PROTECTION AND RESTORATION OF THE ENVIRONMENT XIV

INTERNATIONAL CONFERENCE

PROTECTION AND RESTORATION OF THE ENVIRONMENT XIV

BOOK OF ABSTRACTS

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PREFACE

"Protection and Restoration of the Environment" is a well-known series of international conferences, organized jointly by one American and one Greek University every two years, in Greece. It started in 1992, in Thessaloniki. In 2018, the fourteenth Conference of the series has taken place in Thessaloniki for one more time. It was jointly organized by: a) the Stevens Center for Environmental Engineering of the Stevens Institute of Technology, USA and b) the Division of Hydraulics and Environmental Engineering, and the Environment Council of the Aristotle University of Thessaloniki, Greece.

Thessaloniki is an inspiring place for an environmental conference: It is a large city, facing many environmental problems, but, at the same time, it is situated in the middle of an area of undisputable beauty (including Chalkidiki and Mount Olympus), which exhibits the environmental quality that we have to preserve for future generations.

Moreover, Thessaloniki is located in a rather small distance from Stagira, the birthplace of Aristotle and from Mount Athos. Aristotle contributed decisively to the formation of scientific thought, while Mount Athos represents the spirit and the moral discipline, which are indispensable for protection and restoration of the environment.

The conference was timely, as well. It served as a reminder that protection of the environment is not a luxury that could be temporarily disregarded under the pressure of financial crisis, but a basic prerequisite for viable future.

Participation has been very encouraging. Almost 150 papers have been selected for oral or poster presentation, covering a wide range of topics, which reflect the interdisciplinary nature of environmental challenges. They have been classified in the following sessions:

- Climate change impacts and adaptation measures
- Cultural and social issues
- Environmental education
- Environmental hydrology
- Environmental law and economics
- Ground water resources management
- Protection and restoration of coastal zone and open sea waters
- Protection and restoration of ecosystems
- River and open channel hydraulics
- Soft and renewable energy sources
- Solid waste management
- Sustainable architecture, planning and development - Built environment
- Sustainable architecture, planning and development - Urban environment
- Water and wastewater treatment and management
- Water resources management and contamination control

The conference hosted also a special session on Supporting Sustainable Development Goals Implementation using research, organized by the Sustainable Development Solutions Network (SDSN).

The editors would like to thank:

The authors of the papers, for contributing and sharing their own expertise.

The members of the organizing and the scientific committee, for their eager help.

The reviewers, for ensuring high scientific standards for the presentations.

The sponsors of the conference for their financial support.

All conference participants, for their active involvement in the exchange of knowledge, which is the essence of a conference.

The editors

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Water resources management and contamination control

CLIMATE CHANGE EFFECTS ON THE AVAILABILITY OF WATER RESOURCES OF LAKE KARLA WATERSHED FOR IRRIGATION AND VOLOS CITY URBAN WATER USE

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Abstract

Climate change and its potential impacts on water resources may have a large impact on water resources and subsequent water resources management practices. Changes on future climate will likely affect the fundamental drivers of the hydrological cycle, rainfall and temperature. The Representative Concentration Pathways (RCPs), which simulate future projections of GHG emissions and atmospheric concentrations, are used to model future changes in these variables. The RCPs include a stringent mitigation scenario, one intermediate scenario and one scenario with very high GHG emissions until year 2100. Subsequent changes in rainfall and temperature are used to examine climate change effects on two study areas; an agricultural watershed and an urban city, in Thessaly, Greece. Lake Karla Watershed, a typical Mediterranean agricultural area with dry climate, and the neighboring city of Volos are examined. The Water Evaluation And Planning (WEAP) modeling system is used to simulate the water availability for historical and future periods and for various water uses. More specifically, the water balance is simulated under the three extreme climate change scenarios and current operational management practices. The two study areas are modeled separately in the Baseline Scenario. In the future, when the new reservoir of the technical Lake Karla will operate, 50 new drilling wells will also be used for the coverage of the urban water demand of Volos city. Thus, the two areas are connected and modeled as an integrated system in the future scenarios. Finally, a management scenario of irrigation and urban losses reduction is suggested and simulated (for the current and for the future conditions) under the climate change scenarios. The results of the water balances indicate the vulnerability of the study areas, especially of the agricultural watershed, under the climate change, and the alteration the of current water resources management practices is deemed necessary.

Keywords: water resources management, Water Evaluation And Planning system (WEAP), Lake Karla Watershed, Volos city, climate change.

DEVELOPING AN INTEGRATED SURFACE WATER-GROUNDWATER MODELING SYSTEM FOR UPPER ANTHEMOUNTAS BASIN, GREECE

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Abstract

The need of integrated surface water-groundwater management is well recognized, since this type of management can provide a comprehensive and coherent understanding of the water cycle on catchment-level, leading to the proper and efficient use of water. Moreover, integrated water resources management (IWRM) is strictly imposed by the European Union Framework Directive 2000/60/EC and all relevant European and national legislation. An important role towards the successful implementation of IWRM plays the application of numerical modeling, through the coupling of hydrological models with groundwater flow models. Model coupling, even though it is a complex procedure including a number of conceptual and computational challenges, is widely used in modern IWRM. In this perspective, the present study investigates the interaction between surface water and groundwater on catchment-level by developing an integrated modeling system consisting of a hydrological and a groundwater model. The hydrological model was constructed within the framework of the widely used software Soil and Water Assessment Tool (SWAT), while the groundwater model was formed applying the MODFLOW code, which has evolved into the worldwide standard computer program used in groundwater modeling. The aforementioned models were interlinked and applied for the combined simulation of hydrological processes and groundwater flow in Upper Anthemountas basin. Moreover, a sensitivity analysis was performed in the case of groundwater flow model in order to investigate the impact of various model parameters (e.g. hydraulic conductivity, storativity, wells pumping rates, boundary conditions) on the model results (hydraulic head), which will be helpful in the case of a future calibration of the model.

Keywords: integrated water resources management; hydrological modeling; groundwater modeling; surface water-groundwater interactions; Upper Anthemountas basin

COMPARISON OF STOCHASTIC AND MACHINE LEARNING MODELS IN STREAMFLOW FORECASTING

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Abstract

One of the fundamental issues of hydrology is the rainfall-runoff relationship and streamflow forecasting that plays an important role in water balance. Up-to-date a large number of models have been developed to simulate the relationship of rainfall-runoff and forecasting the streamflow. In the present study a comparison between stochastic and machine learning methods is performed with respect to their forecasting capabilities and their performance and reliability in short term streamflow forecasting is evaluated. For this purpose, five popular methods were employed, two stochastic methods and three machine learning models, specifically Auto Regressive Moving Average (ARMA), Auto Regressive Integrated Moving Average (ARIMA), Multilayer Feed-Forward Artificial Neural Network (MFNN), Bayesian Neural Networks (BNN) and Ensemble methods (Boosting). The daily rainfall and streamflow data of two mountainous watersheds were used as a case study for developing the rainfall-runoff models. The performance and reliability of the models were evaluated through three different criteria: correlation coefficient, root mean square error and mean absolute error. Each criterion is represented by an efficiency indicator, estimated from the comparison of predicted values and the measured targets that have been initially placed. The objective of this paper is to illustrate the effectiveness of stochastic and machine learning models in streamflow forecasting. Our results show that both the stochastic and machine learning models can successfully approximate the rainfall-runoff relationship and efficiently estimate the resulting streamflow. The results from the individual methods do not differ dramatically and by and large all models have good performance and provide accurate predictions, but the best performing model is BNN.

Keywords: streamflow forecasting; ARMA; ARIMA; artificial neural networks, Bayesian neural networks; boosting

APPLICATION OF MODIFIED METAHEURISTIC METHODS TO IDENTIFY CRITICAL AREAS IN WATER SUPPLY NETWORKS

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Abstract

Recently, metaheuristic methods have actively been used to minimize the cost of water supply networks. The algorithms of these methods search for optimal solutions using local searching strategies, thus skipping the exhaustive search analysis. Brute-force searching methods are also used and are typical for limited system sizes. However, brute-force is not commonly used in real-world problems due to time limitations and scaling problems. though metaheuristic search is more common for these case, they also have some limitations. Sufficiently large water supply networks or very small size of the mesh are typical cases that make computational time very long so that these methods never find the optimal solution. In this paper we try to overcome these limitations by applying a modified metaheuristic method in order to identify critical clusters of water pipe networks.

Keywords: metaheuristic; water supply networks; harmony search algorithm; pipe networks; water management

HORIZONTAL CONVECTION INDUCED BY ABSORPTION OF SOLAR RADIATION

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Abstract

In the present study, the formation and development of horizontal convective currents between open water and a shaded area are investigated numerically. Differential solar heating can result from shading aquatic canopy, producing a temperature difference between the shaded and illuminated region. The unsteady two-dimensional Navier-Stokes (NS) equations are used in conjunction with the energy equation, where the latter accounts for the absorption of radiation through an additional source term. The Boussinesq approximation is applied for taking into account the density difference due to temperature difference in the buoyancy term. Two radiation models are being implemented, one based on Beer's law and the other on the Radiative Transfer Equation (RTE). Both models divide the incoming radiation into three bands, each having a specific absorption coefficient. The RTE incorporates the emission and scattering processes, besides the absorption term, while Beer's law model uses only the absorption term. The effect of Grashof number (Gr), ranging from 10^7 to 10^9, on the characteristics of the convective currents are examined. The numerical results for the current velocity and water temperature profile are presented and compared against available experimental data.

Keywords: horizontal convection, absorption, radiation, Beer's law, Radiative Transfer.

SUPPORTING INTEGRATED WATER RESOURCES MANAGEMENT ON THE ESTABLISHMENT OF THE MAXIMUM WATER LEVEL IN LAKE VEGORITIDA

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Abstract

Water is a key element in sustaining any environmental and socio-economic balance. With the current context of rapid changes on hydrological and socio-economic patterns, water resources management is facing a special challenge, which is no other than dealing with competing claims of various stakeholders on water, or in other words, with water resource dilemmas, such as the determination of the maximum water level in Lake Vegoritida (Northern Greece). The lake's water level has undergone great changes, throughout the last decades, caused by severe water abstraction directly from the lake and its catchment. Along with the water level changes, it is not only the natural environmental conditions that have adapted to a new status, but also the social and economic ones. Nowadays, a discussion about the decision for the maximum water level in Lake Vegoritida becomes a source of conflict among stakeholders who have different claims and interests around the lake. In this paper, an outlining process is followed that includes the identification of stakeholders and the issues related to lake's water level, as well as the effects of alternative proposed scenarios of maximum water level on the natural and socio-economic environment. The engagement of the identified stakeholders in a management and decision-making process should be taken into account by the competent authorities towards the establishment of an environmentally sustainable, socially equitable and economically efficient maximum water level in Lake Vegoritida.

Keywords: lake level management; environmental aspects; socio-economic aspects; stakeholders; IWRM

RAINWATER HARVESTING AS AN ALTERNATIVE SOURCE TO CONFRONT WATER SCARCITY WORLDWIDE – CURRENT SITUATION AND PERSPECTIVES

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Abstract
Earth's arid and semi-arid regions were always faced water scarcity problems due to the lack of precipitation and its unpredictability. However, there is global pressure on available water resources, which not only has demographic, economic and social causes, but also is connected with climate change. Rainwater harvesting (RWH) is an alternative source of water applied since antiquity. The practice is still in use in many areas throughout the world as it is adopted by many countries as a viable decentralized water source. Rainwater collection, protection and re-use are a viable process that can both significantly increase available water resources and reduce flood risks. The degree of its modern implementation varies greatly across the world, often with systems that do not maximize potential benefits. In recent decades, many countries are supporting updated implementation of such practice so as to confront the water demand increase, which is related to the climatic, environmental and societal changes. According to the current literature, RWH process belongs to a wider context called Sustainable Drainage Systems (SuDs). It can be applied additionally and designed appropriately so as to reduce frequency, peak and volume of urban runoff. The above thoughts motivate interest in considering the current situation and the perspective to further grow this method worldwide. In the present paper, the current situation of rainwater harvesting as an alternative water source to confront water scarcity around the world is studied. In particular, the paper presents: (a) the causes of water shortage; (b) a brief historical overview of the temporal evolution of the RWH; (c) the causes of the renewal of interest in the RWH technique; and (d) incentives for the spreading of the RWH method in various countries worldwide.

Keywords: Rainwater harvesting, alternative water source, water shortage, arid and semi-arid areas

MULTIOBJECTIVE OPTIMIZATION RAIN GARDENS USING HARMONY SEARCH ALGORITHM

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Abstract
The use of ecological rainwater management method and rain gardens in urban areas aims at: 1) reduction of total rain water runoff and of its peak and 2) reduction of property damage and activity disruption due to insufficient sewer network capacity. Rain Gardens cannot substitute by sewer networks, but they can be used as integral parts of sewer systems in a cost-efficient way. In this paper we apply and modify the Harmony Search Algorithm (HSA) in order to optimize the multi-objective problem of rain gardens. A Matlab script that estimates Pareto front is developed for this purpose. The HSA modification includes a gravity-factors system for every objective function. In conclusion the Pareto front is calculated at four different sets of gravity factors.

Keywords: Rain garden, Optimization, Urban rainwater management, Harmony search algorithm, Metaheuristic methods

ESTIMATION OF WATER FOOTPRINT FOR A HOTEL UNIT

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Abstract
Some of the most important issues concerning water resources are reduction of extreme consumption and protection of their quality. As time passes, researchers are trying to determine more effectively water consumption and pollutant burden which ends up in water resources in order to manage and protect them more appropriately. The constantly increasing water demand has currently led to global problems of pollution and water scarcity. However, the necessity of improving water management has led to the development and application of methods which aim to the extinction or at least the limitation of these phenomena. A recent perception of simultaneously estimating water consumption and water pollution is the concept of the water footprint, which was first introduced by Hoekstra in 2003. The water footprint concept comprises the efforts to identify freshwater consumption, not only through direct but also through indirect use. It forms a volumetric measurement of water consumption and water pollution while it also constitutes the base for local assessment of environmental, social and economic impacts. In this paper, the water footprint of the hotel unit 'Pantelidis' in the town of Ptolemaida, Greece, is analysed. Moreover, solutions that could reduce this footprint and make this industry more environmentally viable, in terms of water use, are being investigated.

Keywords: Water footprint, Water scarcity, Water pollution, Water consumption, Water resources management

SEDIMENT TRANSPORT CASE STUDY: NESTOS RIVER

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Abstract

In the current paper are presented the results of a survey conducted in specific sections of the Nestos river pointing out some of the basic features of the river behavior, in order to create a real data base available to everyone who is interested in further study and research. It consists of two sections; the first one is the calculation of suspended sediment and the second one the calculation of trolling matter. Specifically, in the first part the flow rate and sediment transport were calculated, where it was observed that the increase of flow rate resulted in the increase of sediment transport, which is fully verified by the results of the research and it is concluded that the initiative assumptions were correct. Moreover, in the second part, the transportation of the trolling matter on the field was initially measured and then the same data were reevaluated using the Meyer-Peter and Müller equation, which is one of the most reliable equations concerning the evaluation of trolling matter transport. In the end, after a comparison of the results relative convergence was observed and the results are reliable for use, expressing the basic characteristics of the Nestos river.

Keywords: Suspended sediment, trolling matter, flow rate, Nestos river, Meyer-Peter and Müller equation

ASSESSMENT OF IRRIGATION WATER QUALITY IN ANTHEMOUNTAS BASIN, CENTRAL MACEDONIA, GREECE

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Abstract

This research focuses on the assessment of irrigation water quality in a cultivated basin (Anthemountas Basin) of central Macedonia, Greece. Specifically, it was performed a risk assessment of soil salinization or alkalization due to irrigation water quality, as well as an assessment of the anticipated adverse effects and the potential toxicity in crops due to the presence of harmful substances in irrigation water. In this context, 45 samples from irrigation boreholes were analyzed for assessing electrical Conductivity (ECw), pH, Sodium Adsorption Ratio (SAR), Na, Ca, Mg, Cl and B. Results revealed that regarding ECw, 71% of boreholes appeared to have values below 0.7mS/cm, hence characterized as of negligible risk, and 29% of the boreholes had values between 0.78-1.1mS/cm, hence characterized as of small to medium risk. In respect to crop toxicity due to the concertation of specific ions at soils, the risk due to sodium (Na) and Chlorides (Cl) appears to be low; however, the risk due to boron (B) appears to be significant in a few cases accounting for concentrations up to 2.87 mg/L in irrigation water. The pH values are within the acceptable range of irrigation waters and the probability of irrigation system clogging due to salinization effects appears to be low to negligible. Nevertheless, agricultural practices including the management of irrigation water resources should be frequently monitored and managed rationally in order to maintain an optimal quality status of water reserves and soils, hence contributing significantly to the sustainable agriculture. Towards this direction, specific suggestions are given taken into account the specific conditions and characteristics of the area.

Keywords: Irrigation water quality; salinization; alkalization; crop toxicity; Anthemountas basin

GIS-BASED MULTI-CRITERIA DESIGN OF A HYDROMETRIC SYSTEM IN THE ATTICA REGION

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Abstract
The lack of adequate hydrological data affects the ability to model, predict and take measures for catastrophic events, such as floods and droughts, which have obvious negative impacts on public health and socio-economic aspects. The collection of stream flow and stage-gauge measurements that are accurate and representative for a watershed is necessary; however, it is difficult to decide for an optimum stage-gauge station location. This research work presents a methodological framework based on Geographical Information Systems (GIS) techniques and multi-criteria decision-making (MCDM) for the optimal design of a Hydrometric Station Network. The implementation was held in seven basins in Attica region, namely Sarandapotamos, Giannoula, Eschatia, Erassinos, Rafina, Haradros and Rapendossa. These basins face an existing flood hazard, especially in the residential areas. In the context of the optimal network design, different criteria, such as morphology, land cover, network density, and general guidelines of the World Meteorological Organization (WMO) were taken into consideration. The criteria weights were estimated with the use of Analytic Hierarchy Process (AHP) and the final results, based on the Weighted Linear Combination (WLC), indicated the optimal hydrometric stations locations for each basin. Furthermore, a sensitivity analysis on factors weights was performed and presented indicatively for Eschatia basin.

Keywords: hydrometric station network; river monitoring; floods; GIS; MCDM



Sustainable architecture, planning and development - Built environment

LIFE CYCLE ASSESSMENT OF MODERN AND TRADITIONAL MASONRY MORTARS FOR SUSTAINABLE CONSTRUCTION

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Abstract

Sustainability in construction has become even more essential over the past few decades, mainly due to natural resources overexploitation, as well as an increasing rate at construction-related emissions that contribute to major environmental issues, such as climate change. The rising demands in affordable housing and in the utilization of environmentally efficient alternatives, led to the revival of traditional building materials in modern construction. Clay and traditional materials in general, are considered sustainable materials mainly because of the harvesting method that makes them easy to produce. At the same time, these materials are being used in conservation and restoration of historic buildings, not only for their compatibility with the existing structure, but also for their economic and environmental benefits. For this paper, an effort is conducted to assess the environmental and financial benefits of three of the most common traditional building materials used in the production of masonry mortars: clay, lime and pozzolan. A cement-based mortar is also assessed, as a reference mixture. The environmental assessment is conducted according to the Life Cycle Assessment methodology, a comprehensive tool that is used extensively in construction applications. Along with the environmental assessment, a cost estimation of the different scenarios presents their financial profile and the potential for implementation in the construction industry. The results of the study document the sustainability of the traditional materials and clarify, in a quantitative way, the importance of the utilization of traditional materials in masonry mortars, leading to benefits for both modern construction and conservation and restoration projects.

Keywords: Sustainability, traditional building materials, masonry mortar, life cycle assessment

HAZARD ASSESSMENT AND VULNERABILITY REDUCTION IN THE MEDITERRANEAN LANDSCAPE: THE CASE OF CRAPOLLA ARCHEOLOGICAL SITE IN THE SORRENTO-AMALFI PENINSULA, ITALY

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Abstract

The Crapolla Fiord, near to the Amalfi Coast, thanks to its special landscape, can be classified as an example of a Mediterranean landscape, with exceptional cultural and natural scenic values, resulting from its outstanding nature and historical evolution. The area hosts the archaeological site of the San Pietro Abbey, built before the 12th century, and the so-called "monazeni", vernacular constructions used by local fishermen for boat sheltering. At present, the site has been just interested by a deep research experience leaded by the Department of Architecture (DiARC) of the University Federico II. The study, committed by the local Municipality of Massa Lubrense involved a range of specialized knowhow represented by four different departments of the University of Naples Federico II, including an important archaeological survey campaign. As part of the study, the analysis of the surface-water hydrology has carried out at local scale, by the aim of assessing hazard potential for the site conservation. The current land cover is bare soil on a specific rocky substratum, although traces of terraces dating from the time of the Abbey activity are still recognizable. Taking into account the site exposure (South), its land use, as well as the scenario of further climate change - consistent with the A1B like scenario (IPCC, 2014) - the increase of site vulnerability is expected. Starting by these assumptions, the study evaluates the hydrology hazard potential in estimating the variations in flow rates at secondary auctions, comparing current Land Cover and the one at the time of Abbey activity,. Due to both the reduced infiltration capacity and the local climate specific, the increase of hazard potential is expected, as well as the rise of the site vulnerability, and the intensification of the values exposed in terms of losses potential (the immaterial value of the cultural asset) and hence the increase in overall site risk. The study quantifies the hazard potential and demonstrates that the introduction of small interventions aimed at regenerating vegetation and/ or at increasing infiltration capacity, would be justified and sustainable.

Keywords: Risk assessment, Cultural heritage, Climate change impact

TERRACED LANDSCAPES LOCATED IN AREAS OF GREAT VALUE FOR TOURISTIC PURPOSES AS AN IRREVERSIBLE PRACTICE

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Abstract

Since Neolithic, terraced landscapes have been an essential element for moulding mountain or steep slope into habitable arable areas. Over the last decades, they have been subjected to a quick abandonment because of their inadequate economic competitiveness causing a gap in their maintenance and, consequently, incrementing the hydrogeological instability of those areas. Minori is a small municipality (256 ha), protected by UNESCO, located in Amalfi Coast. That area is well known not only for the beauty of its territory but also for some catastrophic raining events, like in 1954 when a rain shower of 500 mm topped up to 24 hours. The current research work intends to analyse the landscape changes in Minori over sixty year period (1956 - 2017) for assessing the new values taken on the land use and the agricultural sites. A detailed orthophoto and a high resolution Digital Elevation Model (DEM) of the study area have been reconstructed using the historical photogrammetric photos of 1954, acquired by the Italian Military Geographic Institute (IGM), and the aerial photogrammetric pictures of 2017, obtained by an own flight. DEM and orthophoto have been reconstructed applying Agisoft Photoscan Professional. The resolution of the generated DEM is equal to 0.48 and 0.1 m for 1956 and 2017, respectively. The orthophoto resolution is of 0.24 and 0.07 for 1956 and 2017, respectively. Comparing the generated products of the two periods, it is pointed out that terraces extension has not been amended, while the amount of human constructions have increased of about 800%. To give a first idea of the most vulnerable areas to be investigated more in depth through simulation procedures, a first proposal of an expeditious index of vulnerability (EVI) has been introduced and tested. It is based on the ratio between the amount of surface occupied by buildings and the amount of areas subjected to a debris flow event. The increase of the vulnerability, exposure values and probability of accident occurring involve a risk rise.

Keywords: Agricultural terraces, Risk assessment, Aerial photogrammetry, Historical series

PRELIMINARY INVESTIGATION OF THERMAL EFFECT IN STREET CANYONS

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Abstract

Modern cities suffer from degraded air quality caused among others by the nature and the characteristics of the urban infrastructure and the contemporary building types and construction styles. Street canyons, created by continuous building alongside narrow or medium width streets, are quite common in many cities. They have a negative effect on urban air quality and thermal comfort conditions of city inhabitants. The aim of the present work is to simulate and predict flow fields at street canyons, as well as to assess the resultant heat fluxes. It analyses the aforementioned phenomenon under four scenarios changing the sources of heat fluxes. For this purpose a computational fluid dynamic model is used. Based on the results, the most adverse effect is found at about the middle of the building height, when considering as source of heat flux the building face, where the maximum temperature near the building is found. The temperature at the intermediate places of the city canyon remains, as expected, at lower levels than the temperature close to the heat sources. It is of note that the warm air near the building faces will deteriorate the comfortable interior room climatic conditions.

Keywords: street canyons, thermal effect, CFD, heat fluxes, room comfort

IMPACT OF THE TUMULUS ON THE STABILITY OF MICROCLIMATE IN UNDERGROUND HERITAGE STRUCTURES

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Abstract

After having scientific documentation of the variations of temperature and relative humidity inside three Macedonian tombs excavated in the area of Pella and Agios Athanasios, comparative analysis of the data was conducted. The analysis of the hydrothermal behavior of these underground chambers showed that the tumulus protected the tombs and their treasures against the deterioration processes.

The tumuli over tombs in north Greece named “Macedonian tombs” were constructed in ancient times as “far seen signs” of important persons’ burials. Structurally, the tumulus is a big mass of artificial earth, covering monumental tombs which are dated between the 4th and 2nd century B.C. Its construction is the artificial packing of different layers of earth, with different consistency. These layers created a perfect drainage system. This way, the rain water was directed to the periphery of the cone-shaped tumulus and not inside the tombs. Because of the thermal inertia of the surrounding soil, fluctuations of temperature were of less width inside the tombs than outside. The tombs were preserved under stable microclimatic conditions in a very good state.

This study shows that the tumulus is a very important technical achievement for its era, not only due to its great mass -sometimes 12 m. high, but due to its construction and the impact to the protection of the underneath tombs, which are significant heritage structures. Other factors that affected the microclimate stability inside the tombs were the volume of the interior space, the rate of exposure to the external climate and the protection measures after the excavation. Estimations according to the analysis are presented in this paper.

Keywords: Microclimate, Hydrothermal performance, Heritage structures, Macedonian tombs, Tumulus

COMPARING ENVIRONMENTAL IMPACTS OF TWO OFFICE SEATING UNITS VIA LIFE CYCLE ASSESSMENT

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Abstract
This study aims to compare the environmental impacts of two office-seating units via life cycle assessment (LCA) methodology. The system boundary covers raw material extraction and pre-processing, transportation, manufacturing, distribution and usage and end of life stages. Therefore, the results are obtained on the whole life cycle. The evaluated impact categories are as follows: Global warming potential (GWP), acidification potential (AP), eutrophication potential (EP) and photochemical ozone creation potential (smog) (POCP). This study is a pioneering one conducted on the Turkish furniture industry. For both of the seating units under investigation raw material extraction and pre-processing stage have the highest share in all impact categories. Considerable differences in impacts are observed for the two seating units evaluated.

Keywords: environmental impact; life cycle assessment; furniture; office seating; sustainability

REGENERATION AND PLACE-MAKING THROUGH HERITAGE: A CASE STUDY FROM A HISTORIC BUILDING IN NORTHERN GREECE

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Abstract
Cities are entering a new era underpinned by theoretical notions concerning their role as nodes in a global competitive network. Urban areas of historical value are spatial structures that express the evolution of the local society and its identity. Urban building stock with its connotative meanings is an important part of the city as historical and cultural evidence. Within this framework, urban regeneration is encouraged by local authorities to attract people. Rapid transformation of urban buildings of historical significance, urban area revival and aesthetic investments are some of the regeneration strategies towards revenue-generating potential and more sustainable urban forms.

Contemporary urban regeneration projects aim to plan creative spaces by reintegrating historic complexes and buildings in the city and by creating distinctive urban areas with various functions and a sense-of-place. Placemaking is an inherently collaborative and inclusive planning approach compared to the envisaged planning model. As a concept it refers to the process of place production with the aim to advance the living quality of a space. People are attracted to places which can become focal points of economic, social activity and attractiveness including various functions.

This paper faces an important challenge in the field of urban heritage regeneration towards the sustainable city. The paper focuses on a listed building of the rich historical building stock of Thessaloniki in Northern Greece, the Branch of the 1st Secondary School (former Josef Modiano Mansion). In particular, through this case study, the paper explores a series of issues associated with the rehabilitation of abandoned historical buildings and their reintegration in the modern city through placemaking strategies. The ultimate goal is to propose new aspects of urban building upgrade through new creative uses and introduce a community based regeneration methodology.

Keywords: Urban regeneration; cultural heritage; place-making; historical buildings; sustainable city

Protection and Restoration of the Environment XIV

Environmental education

RAISING AWARENESS ON CLIMATE CHANGE THROUGH HUMOR

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Abstract

Environmental awareness, for issues like climate change, is on top of the list with the concerns, humanity is facing. We are being exposed to a gigantic number of environmental messages but still we haven't reached the optimum level of environmental sensitivity.

Most of the climate change awareness campaigns use fearful stimuli such as scary titles, and images of catastrophes and uncertain futures. That kind of campaigns create emotions like fear, anxiety and worry to the public. That's an explanation why lots of people ignore climate change and deny its importance. According to various researches, humor can boost successfully educational and communication processes at stake. Participants being confronted with pleasant approaches have responded positively to the new information and their intention to retain longer their behavioral change has been recorded.

Through a quality process, this study aims to study the importance of humor, and how it can be used in climate change awareness campaigns in a way that will influence public's attitudes and behavior, so that a positive response will be created.

Keywords: Climate change, Humor, Environmental awareness, Environmental communication

EARLY CHILDHOOD ENVIRONMENTAL CAMP IN A GREEK PORT

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Abstract

In Greece, the Port of Skyros Island has established an environmental campaign in its area, which is running for the last three years. The name of the above campaign is “SKYROS Project”. It is a cooperative project between the University of the Aegean and the Skyros Port Fund. Since 2015, every summer, academic students and researchers of the Research Center of Environmental Education and Communication of the Department of the Environment of the University of the Aegean are visiting the Island of Skyros in the spectrum of their internship requirements. The environmental communication tasks of SKYROS Project include a variety of different environmental actions. One of them is the Environmental Kids’ Camp, in which children 6 to 13 years old are participating in environmental education programs. They are being educated in a specially designed area, on how to take care, respect and protect the environment. The ultimate goal is to create environmentally active citizens with a responsible behavior. So, the main object of this research is to create a program complementary to the one already existing, based on environmental education guidelines for early childhood. For the first time, this summer of 2018, the research team of SKYROS Project will attempt to involve kids of early childhood age as well.

This program provides the opportunities for young children of locals and tourists to participate in a variety of eco-social interactions, including playing and exploring the outdoors. Based on a quality assessment process, this paper will present the benefits of environmental education in early childhood in outdoors places, like a port. The extension of the environmental camp would be based on the Guidelines for Excellence of the North American Association of Environmental Education. The overall goal of these guidelines is to chart an appropriate and positive process whereby educators can start young children on their journey towards becoming an environmentally responsive youth and later on adults. Environmental education in early childhood is a holistic concept that encompasses knowledge of the natural world strengthening this way environmental literacy for all.

Keywords: Environmental education, Environmental camp, Early childhood, Outdoor activities, Environmental responsible behavior

IN SEARCH FOR AN ISLAND TO HOST AN ECOVILLAGE

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Abstract

Creativity has come to be viewed as a source of competitive advantage in social life, emerging from a set of financial and social concerns affecting daily routine in our days. This research proposes the operation of an ecovillage, where responsible environmental behaviors will be enforced through "creative tourism". Researchers show that creative tourism makes available to visitors the chance to develop their creative skills through active participation in learning experiences.

The proposed Ecovillage in Skyros Island, Greece, will be accessible to families who wish to spend their vacation time in environmentally inspired set ups and use the opportunity to personally contribute to environmental protection as well as expose their children to ways to actively object to environmental issues of concern. Also, it refers to groups of people who don't have to be physically at work, like digital nomads, who choose as living set up an environmental awareness type of community. Specifically this study attempts to assess all activities, educational and empirical, which will be offered to visitors/residents of an "ecovillage". A complete search of related literature guides the tasks and services that would be offered to those spending their vacation time at the proposed ecovillage. In detail the participants would be active operators of the sustainable living structure and their needs will be based on the concepts of environmental conservation and protection in order to minimize the consequences that affect irreversibly nature and human life. Through their daily involvement at this chosen vacation format, environmental awareness will be accomplished in a successful manner. For the young ones the ecovillage will hold a daily environmental camp tailored to the needs of the participant children.

Keywords: Ecovillages, Circular economy, Creative tourism, Environmental education

AUGMENTED REALITY PROVES TO BE A BREAKTHROUGH IN ENVIRONMENTAL EDUCATION

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Abstract

This paper deals with the implementation of augmented reality technology as a means of communicating environmental issues and boosting environmental education for 241 school students in the 4th, 5th, 6th classes of two primary schools in Athens, during the course of Computer Science. Specifically, an early version of two augmented reality applications for android mobile devices were designed and deployed. Two activities combining this technology were designed in order to address environmental learning goals concerning climate change concepts and fundamental aid in the understanding of renewable energy resources. The study assessed whether the students liked the applications and the rate of knowledge change, driven by pre-post questionnaires, which were given both at the start and at the end of the implementation. The results showed that the implementation of Augmented Reality applications for environmental educational concepts have a significant supplemental learning effect as a mobile-assisted learning tool. Finally, the paper concludes with future guidelines in the field of other environmental issues of great importance.

Keywords: augmented reality; environmental education; mobile education; climate change; renewable energy sources

RECYCLING AND EDUCATION THROUGH DIGITAL STORYTELLING IN THE AGE GROUP "8-12" IN GREECE

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Abstract
In this study, primary school students were assessed on their environmental knowledge on recycling, upcycling, their attitudes and willingness to change behavior, after their exposure to digital social stories. Specifically, we propose the creation and the application of particular teaching interventions in classes of primary school of Greece. This implementation concerns the use of a web tool, Pixton, to educate students on the process of recycling, reusing and reducing. Specific digital stories with recycling content were created by the participant students under given guidelines, developing their own stories. In order to conduct the survey, 689 students participated from both urban and rural regions. The results have shown that the implementation with Pixton tool has influenced the level of knowledge, attitude and willingness to change behavior of the students.

Keywords: Recycling, Digital storytelling, Environmental attitude, Willingness to change behavior, Education awareness, Learner-generated comics

SOCIAL EXPERIMENT IN THE ENVIRONMENTAL FIELD OF EDUCATION

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Abstract
Climate change that has taken place over the last few decades requires a different approach of the environment. For this reason, a different philosophy and behavior of citizens is needed, characterized by respect and proper use of the environment, stimuli acquired mainly through education. The aim of this paper is to identify the problems and the dissuasive trends as well as to highlight actions and motivations for environmental awareness and activation, in order to show and build an innovative and efficient model of education and mobilization. This research was carried out using the "questionnaire" method, as well as the statistical analysis and the statistical sample came from students of secondary and tertiary education in Northern Greece. In particular, it focused on the active population of society so as to have on the one hand the necessary maturity required for the problems to be taken into account and on the other hand the potential for immediate activation.

Keywords: Environment, Education, Innovation, Action, Questionnaire

Protection
and
Restoration
of the
Environment
XIV

Sustainable architecture, planning and development - Urban environment

SUSTAINABLE URBAN PLANNING AND ENVIRONMENTAL IMPACTS: FROM THEORY TO PRACTICE THROUGH INTERNATIONAL CASE STUDIES

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Abstract

It is widely recognized that there is a strong relation between planning, sustainable development and environmental management: planning is an essentially collective, public interest activity, which operates to secure the efficient and effective development and use of land (in the public interest), and today a planning system should aim at guiding policy formulation and decision making towards the goal of sustainable development. In most developed countries, the planning system is seen as a key instrument in the delivery of sustainable development. Effective use of resources and materials, energy efficiency, sustainable water resources management, atmospheric conditions and climate factors and effective waste management towards a cycle economy reflect some crucial parameters that can be related to planning in the 21st century.

In the present paper, examples of how sustainable planning strategies are implemented in several urban areas internationally, are presented and conclusions are reached towards the target of sustainable communities and high quality of life in urban areas. Furthermore, it is examined whether and how the new Hellenic planning framework, as described by the Law 4447/2016, is capable of establishing a stronger connection between future planning projects and sustainable development in communities and urban areas. Special focus is placed on Local Spatial Plans, which reflect the new key instrument for sustainable planning of Hellenic municipalities, while only predictions can be made, as the new planning framework has not yet been implemented in practice: the technical requirements of the new planning projects have just been enacted in June 2017 (Ministerial Decision 27016/2017). Therefore, assumptions can be made, based on similar planning projects' experience, on the efficiency of the new tool in promoting sustainable urban planning, diminishing the urban 'footprint' of Hellenic municipalities and dealing successfully with bureaucratic processes in planning projects until their final approval by the necessary Presidential Decree. It is predicted that Local Spatial Plans of the new Law 4447/2016 will be more effective in protecting ecologically sensitive areas, promoting more effective waste management and sustainable transport mobility; however, they will demand a great effort and extended time to be finally, approved by a Presidential Decree.

Keywords: Sustainable urban planning, General Local Plans, Local Spatial Plans, The Law 4447/2016

A NOVEL METHOD FOR STRATEGIC ENVIRONMENTAL ASSESSMENT OF PLANNING PROJECTS: THE CASE STUDY OF THE GENERAL LOCAL PLAN OF GJIROKASTRA MUNICIPALITY, ALBANIA

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Abstract

The planning system is Albania is currently under reform, while in many municipalities General Local Plans (GLPs) are conducted, with the aim of environmental protection of ecologically sensitive areas, housing needs definition, new technical infrastructure identification, future development action prediction and new building regulations' formulation for urban areas. Within the planning process, there is an effort to enhance public participation, through specific procedures with public hearings and specialists' meetings, promoting publicity and thus, transparency. As part of the planning process, Strategic Environmental Assessment (SEA) studies are also conducted as necessary environmental appraisal studies of the strategic proposals of the GLPs. Such planning and environmental projects include several difficulties related to: lack of experience from public authorities; possible weak public participation and consultation; and expectations from municipalities that may not be met, etc.

A novel method for strategic impact assessment is described in the present paper, reflecting a three-level assessment with the aid of the tool of matrices, which are used in the first step of impact identification, then in the second step of impact prediction and then in the last step of impact evaluation. The purposes of the implemented method are: to be effective in strategic impacts assessment of the GLPs' proposals; to be easy to be used in several SEA studies for GLPs and not just one specific study; to be comprehensive to the public authorities in Albania, which probably do not have much experience in such environmental studies; and finally, to be simple and comprehensive as well, for stakeholders and local people, so as to participate in public hearings and affect positively the process of environmental appraisal of planning projects. The findings of a case study of the SEA Study of the GLP of Gjirokastra Municipality are presented, showing great results and success in the implementation of the tool of matrices in the three-level impact assessment.

Keywords: Strategic environmental assessment, General Local Plan, Matrix, Identification-prediction-evaluation

ANALYSIS AND MODELLING OF BIOLOGICAL WEATHER DATA IN THESSALONIKI, GREECE

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Abstract
We study the levels and the profile of aeroallergens (pollen and fungal spores), which constitute biological weather parameters affecting health and quality of life, in the city of Thessaloniki, Greece. We employ a data-driven approach with the aim to investigate the relationships between aeroallergen parameters as well as meteorological conditions that may dictate biological weather patterns and levels. A number of computational experiments are performed to assess the ability and performance of various statistical and machine learning methods including linear regression, artificial neural networks, decision trees and ensemble-based approaches. Results suggest that it is possible to properly describe the behaviour of the aeroallergens and thus to operationally forecast their levels. The latter is expected to have a direct positive impact of the quality of life of aeroallergen sufferers in the area of study.

Keywords: Aeroallergens, Computational intelligence, Regression

PM_{10} LEVELS OF THE CITY AND A SUBURB OF PATRAS, GREECE, DURING THE PERIOD 2013-2015

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Abstract

The present work deals with the concentration levels of air-borne particulate matter of diameter less than 10 μm (PM_{10}) of the area of the city of Patras and of the University of Patras Campus during the period of 2013 - 2015. The stationary air pollution monitoring station of the Environmental Engineering Laboratory (EEL) of the Civil Engineering Department of the University of Patras is operating continuously since 2012. The sampling site is in a suburb. Additional PM_{10} data are obtained from the "Greek National Monitoring Network of Atmospheric Pollution (GNMNAP)" for two air quality stations, which are installed in Patras downtown and have operated intermittently since 2001.

The monthly variation of PM_{10} concentration for the time period 2013 -2015 is presented at each station. Calculating Spearman's correlation factor, the correlation among stations' measurements is significant at 0.01 or 0.05 levels, but there is no correlation between EEL's data and warm or cold period. On the contrary, there is rather strong correlation between downtown data and warm or cold period. In addition, the monthly average values of a typical year are presented for both stations. Finally, the yearly variations of mean monthly values are shown and the influence of warm or cold period is examined.

The aim of this project is to derive implications from the PM_{10} levels of the air of both the University of Patras Campus and the city of Patras. The statistical analysis of such a program of continuous measurements of air quality may provide a cost-effective strategy for air quality monitoring.

Keywords: Air pollution, air quality, PM_{10}, suburban concentration, suburban

SATELLITE DATA AS INDICATOR OF FOREST DIEBACK: THE STUDY CASE OF THE PINEWOOD FOREST OF CASTELPORZIANO (CENTRAL ITALY)

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Abstract

Mapping forest health condition, especially in protected areas, is a major concern for forest planning, biodiversity assessment and for understanding the potential impacts of antropic activities on natural ecosystems. In this context, at wide scale, remote sensing of satellite data is one of the most important data sources for monitoring health state of forest stand. Till now, many satellites and sensors with different resolutions suitable for variety of land cover monitoring tasks have been launched. Within all these sensors, those with high temporal and spatial resolution play an important role especially in mediterranean environment where high landscape fragmentation and spatial distribution of stand forest represent a limiting factor in vegetation analysis.

The current work deals with the use of the Sentinel-2 images to produce long-term monitoring system based on the Normalized Difference Vegetation Index (NDVI). The study area is represented by the pinewood forest of Castelporziano, a protected area located in the metropolitan area of Rome (Central Italy), recently involved in a quick decline of vegetative condition due to a scolytidae (*Tomycus destruens* Mill.) pest propagation.

Keywords: Remote sensing, NDVI, Sentinel-2, GIS, Mediterranean pinewood, Insect infestation

SURFACE TEMPERATURES AND THERMAL COMFORT CONDITIONS IN NORTHERN GREECE

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Abstract

This paper aims, through research and field measurements in open urban spaces, to study the behavior and effect of coating materials to the urban microclimate and to draw conclusions regarding the factors that affect the thermal comfort conditions.

The study attempts to benchmark the effect of design parameters of outdoor urban spaces to the microclimate and the comfort conditions. Two urban areas in different urban centers, Thessaloniki and Kastoria in Northern Greece, are investigated. Considering the analysis of the design parameters and the effects of design interventions to the microclimate, it focuses on thermal indices expressing the conditions of thermal comfort of the users of urban spaces.

Keywords: Thermal comfort, PMV, Urban Open Spaces

INVESTIGATION OF THERMAL COMFORT CONDITIONS IN URBAN CENTERS OF NORTHERN GREECE

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Abstract

This study investigates the thermal comfort conditions during the summer period in a central area of Northern Greece, Thessaloniki. In the study area takes place a large number of financial and social activities of the inhabitants.

A number of in situ experimental procedures were carried out. Surface temperatures, microclimatic data and urban morphology data were gathered. Also, simulation models have been used to calculate the outdoor thermal comfort sensation. The thermal comfort indices which have been used is the Predicted Mean Vote, (PMV) which provides the average response of a large sample of individuals, the Predicted Percentage Dissatisfied, (PPD) which provides the percentage of people in a large sample who do not feel comfortable in a space, and the Standard Effective Temperature, (SET).

Keywords: Thermal comfort, PMV - PET - SET



Cultural and social issues

REFUGEE CRISIS: GREEK RESIDENTS' ATTITUDES TOWARDS WASTE MANAGEMENT IN THEIR REGION

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Abstract

Todays' refugee crisis is considered an unceasing challenge of the current century, since the mass exodus of people from their own country has exponentially increased. The consequences of this worldwide phenomenon are much bigger than the actual issue itself. Migrants and refugees flocking into Europe from the Middle East, South Asia and Africa, have presented European leaders and policymakers with a heavy task since the debt crisis. Syria is presenting the biggest humanitarian and refugee crisis of recent years, a continuing cause of suffering for millions of people. This massive immigration is known as the "Middle East Refugee Crisis", and obviously it has affected all the neighboring to Syria, countries including Greece. Refugee movements in such astonishing numbers are prospective to produce rampant, quotidian effects on social, environmental and political sector of the receiving and hosting regions' local community.

The purpose of the present research was to explore the knowledge, awareness and attitudes towards waste management and "special waste" management of residents in Lesvos Island, a migrant receiving community. As "special waste" are considered the life jackets, rubber dinghies and fiberglass boats. In the spring of 2017, a questionnaire-based survey was administered on Lesvos Island. Furthermore, the findings revealed the locals' total environmental awareness as well as their perceptions towards refugee crisis that Greece is being confronted with. The issue of waste management is vital in receiving and hosting regions, since the settlement of refugees in regions that don't have the capacity to absorb the pressure of huge influxes is expected to cause social instability and pose a threat to national security.

Keywords: Syrian Refugee Crisis; Waste Management; Environmental Awareness; Special Wastes; Lesvos; Greece

DEVELOPMENT AND EVALUATION OF A SMART APPLICATION FOR SUSTAINABLE CROP PRODUCTION - CASE STUDY: COTTON (GOSSYPIUM SPP)

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Abstract
The constant evolution of current technologies widens the horizons of practices concerning a number of different environmental sectors. Thus, nowadays it can be possible to implement “smart applications” in micro - managing and improving cultivations to verify the successful outcome of the crops produce. The current environmental situation (climate change, extreme weather conditions, destruction of ecosystems, etc.) calls for the implementation of such methods, in order to protect and insure a framework for sustainable environmental development. The purpose of this paper is to review the present situation of mobile applications which are associated with field crops such as cotton (*Gossypium spp*) and possibly expand the used methodology in other species, in order to provide adaptable plants in the wider spectrum of sustainable production. An application named ‘Cotton Diseases’ was developed via App Inventor 2 an open - source web application, provided by Massachusetts Institute of Technology (MIT), to provide educational and scientific content on cotton diseases and parasites. Whereas, an evaluation was conducted through questionnaires directed to students of Agriculture University of Athens and agriculturalists for the usage of said application. Finally, the research provided a number of conclusions, as well as suggestions to better bridge the gap between technology and environment for a common purpose.

Keywords: Mobile application, Agricultural sector, Environmental sustainability, Technology, Cotton

EXPLORING PUBLIC PREFERENCES AND PRIORITIES FOR CONTROLLING INVASIVE MOSQUITO SPECIES: THE IMPLEMENTATION OF A WEB SURVEY IN GREEK HOUSEHOLDS FOR THE CASE OF THE ASIAN TIGER MOSQUITO

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Abstract
The introduction of invasive mosquito species in the Mediterranean area along with intense urbanization poses new challenges for both scientists and policy makers. The last decade has seen the wide spread of the invasive Asian tiger mosquito *Aedes albopictus* in various urban ecosystems of Greece. Compared to native species, Asian tiger mosquitoes are accompanied by greater risks of infectious diseases, higher nuisance levels, and increased expenses for their confrontation. Consequently, future decisions on mosquito control should take these risks into consideration. Public perceptions and preferences regarding these risks are crucial in order to make decisions more responsive to citizens' needs and thus more effective. The aim of this paper is to investigate various socio-economic aspects of the Asian tiger mosquito problem, through a web-based questionnaire. The survey was conducted nationwide, aiming to record (a) the impact of invasive mosquito species in Greek households, (b) associated costs and perceived risks, and (c) priorities and policy directions in mosquito control. The results indicate that citizens are highly concerned with the health risks associated with the new mosquito species and consider public prevention strategies highly important for the confrontation of the problem. The spatial patterns of these results are further investigated aiming to identify regions with different levels of risk and/or policy priorities.

Keywords: urban ecosystems; Asian tiger mosquito; web survey; infectious diseases; citizens' preferences

ENVIRONMENTAL CHALLENGES TO ACHIEVE THE SDG (11) FOR SUSTAINABLE CITIES - CASE STUDY: TRIKALA, GREECE

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Abstract
Nowadays, over half the world's population lives in urban areas, whereas in Europe, by 2020, it is estimated by the EEA, that almost 80% of EU citizens will be living in cities. This unprecedented urban growth has brought enormous challenges concerning clean water, pollution, greenhouse gas emissions, ecosystem degradation, waste management, security from extreme natural events, health issues and many others.

This paper introduces the concept of urban sustainability and explores the characteristics of the Sustainable Development Goal (SDG) 11, concerning sustainable cities and communities. Measuring sustainability is a complex issue and in the case of a city, is mainly depending on local conditions, as each city operates within a specific ecosystem and a socio-cultural context. Urban sustainability of the city of Trikala, in Greece is tested by analyzing major domains such as water resources, energy sector, transportation systems, waste management, urban green spaces and air quality, whereas, given that cities are hubs for social and human development as well, the cultural heritage is also taken into account. The DPSIR model is used as an analytical framework, through the use of indicators, for the assessment of the current situation. In parallel, a survey to more than 300 citizens of the city of Trikala was conducted in order to identify priorities and values, as well as what is considered most important when it comes to decision making, in order to make life in the city more sustainable. Finally, a number of conclusions and suggestions derived, on the changes that could be made and the actions that should be taken, in order for Trikala to strive for sustainable development.

Keywords: SDGs, sustainable cities, sustainable development, environmental protection, Trikala

INVESTIGATING STAKEHOLDERS PRIORITIES FOR TRANSDISCIPLINARY COASTAL & MARINE MANAGEMENT: THE CASE OF THERMAIKOS GULF

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Abstract

Aim of this work is to investigate institutional stakeholders' priorities, regarding transdisciplinary coastal and marine management in Thermaikos Gulf. The targeted coastal and marine area is shared by four Greek regional units, hosting a variety of human activities such as intense urban development, agriculture and husbandry, industry, mussel-culture, fisheries, tourism, etc. There are more than 90 entities which have some kind of jurisdiction or stake in the management of the coastal and marine area of the Gulf, the majority being sectoral public administration agencies. To cover their range of opinions, we developed and distributed a questionnaire focused in identifying the most important management issues in the area, as well as the main reasons behind the possible management failures until know. To test the questionnaire, we contacted a series of interviews with selected representatives of key management authorities, assisting also to acquire a deeper understanding of the current management regime in the area. Through the results we will: a) attempt a preliminary evaluation of stakeholders' willingness to participate in Science-Policy-Society collaboration processes; b) identify the management issue(s) with the highest importance for the local stakeholders and c) investigate deeper the relationship between key local socio-ecological problems and the current institutional and legal status regarding coastal and marine management.

Keywords: stakeholders' engagement, integrated coastal and marine management, transdisciplinary approaches, Thermaikos Gulf



Solid waste management

LIFE CYCLE ASSESSMENT OF MUNICIPAL SOLID WASTE MANAGEMENT PRACTICES IN CENTRAL MACEDONIA

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Abstract
The continuously expanding amounts of waste produced in the EU constitute a major concern at a European level. Municipal waste management represents one of the most critical problems that need to be addressed in Greece, because of the lack of available funds due to the financial crisis. To date, several illegal landfills still pollute the environment, with Greece being penalized by the European Court of Justice for several cases since 2005. On this basis, the development of an optimal waste management strategy, exploiting all available technologies and taking into account all waste streams is more than critical at a national level. In this work, we focus on the Life Cycle Assessment (LCA) of different scenarios of municipal solid waste management practices in an effort to estimate quantitively their environmental impacts. The work is conducted for the Region of Central Macedonia, Greece.

Keywords: waste management; municipal solid waste; life cycle analysis; Region of Central Macedonia.

INNOVATIVE BIOGEOCHEMICAL SOIL COVER TO MITIGATE LANDFILL GAS EMISSIONS

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Abstract

The municipal solid waste (MSW) in landfills undergoes anaerobic decomposition to produce landfill gas (LFG), which predominantly consists of methane (CH_4) and carbon dioxide (CO_2). Fugitive LFG emissions which are otherwise not targeted by gas collection system escape into the atmosphere, forming one of the largest anthropogenic sources of CH_4 and CO_2 emissions in the United States. The landfill cover soil plays an important role in mitigating the LFG emissions by microbial oxidation of CH_4 to CO_2 thereby reducing the CH_4 emissions to atmosphere. Several researchers have investigated the addition of organic amendments to the cover soils in order to enhance microbial oxidation of CH_4 in landfill covers. In recent years, biochar as an organic amendment has shown promise in enhanced microbial oxidation due to its inert/stable chemical nature to degradation, high surface area, high internal porosity, and high moisture holding capacity. However, in all these efforts there is no regard given to the CO_2 that still escapes into the atmosphere in undesirable amounts. Steel slag, a product from steel making industry, due to its high alkaline buffering capacity, high carbonation potential, and its unique cementitious properties has found numerous applications in civil and environmental engineering. But, until now there has been no study on the potential use of steel slag in landfill covers to sequester the CO_2 emissions. Ongoing research study, funded by the U.S. National Science Foundation, explores the use of BOF steel slag in conjunction with biochar amended cover soil so as to first convert CH_4 to CO_2 by microbial oxidation and thereafter sequester the resulting CO_2 from CH_4 oxidation and the prevailing CO_2 from anaerobic decomposition together by steel slag, thereby significantly mitigating the LFG emissions from landfills. In this paper, a review on the current applications and carbon sequestration mechanisms of BOF steel slag is presented. Finally, the proposed concept of the biogeochemical soil cover for mitigation of LFG emissions and some of the results from a preliminary investigation indicating the CO_2 sequestration potential by steel slag are discussed.

Keywords: MSW landfills, landfill cover; landfill gas; bio-geochemistry; BOF steel slag; biochar; carbonation

CO_2 SEQUESTRATION USING BOF SLAG: APPLICATION IN LANDFILL COVER

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Abstract
Fugitive methane (CH_4) and carbon dioxide (CO_2) emissions at municipal solid waste (MSW) landfills constitute one of the major anthropogenic sources of greenhouse gas (GHG) emissions to the atmosphere. In recent years, biocovers involving the addition of organic-rich amendments to landfill cover soils is proposed to promote microbial oxidation of CH_4 to CO_2. However, most of the organic amendments used have limitations. Biochar, a solid byproduct obtained from gasification of biomass under anoxic or low oxygen conditions, has characteristics that are favorable for enhanced microbial oxidation in landfill covers. Recent investigations have shown the significant potential of biochar-amended cover soils in mitigating the CH_4 emissions from MSW landfills. Although the CH_4 emissions are mitigated, there is still considerable amount of CO_2 that is emitted to the atmosphere as a result of microbial oxidation of CH_4 in landfill covers as well as the CO_2 derived from MSW decomposition. Basic oxygen furnace (BOF) slag is a product of steel making has great potential for CO_2 sequestration due to its strong alkaline buffering and high carbonation capacity. In an ongoing project, funded by the U.S. National Science Foundation, the potential use of BOF slag in landfill covers along with biochar-amended soils to mitigate both CH_4 and CO_2 emissions is being investigated. This paper presents the initial results from this study and it includes detailed physical and chemical and leachability characteristics of BOF slag, and a series of batch tests conducted on BOF slag to determine its CH_4 and CO_2 uptake capacity. The effect of moisture content on the carbonation capacity of BOF slag was also evaluated by conducting batch tests at different moisture contents. In addition, small column experiments were conducted to evaluate the gas migration, transport parameters and the CO_2 sequestration potential of BOF slag under simulated landfill gas conditions. The result from the batch and column tests show a significant uptake of CO_2 by BOF slag for the tested conditions and demonstrates excellent potential for its use in a landfill cover system.

Keywords: CO_2 sequestration; BOF slag; biochar; carbonation; MSW landfills; landfill cover; landfill gas

RECYCLING OF CRT FUNNEL GLASS: A REVIEW OF ITS UTILIZATION IN INTERLOCKING CONCRETE BLOCKS

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Abstract

CRT monitors are evacuated glass envelopes containing an electron gun and a fluorescent screen and when they are dismantled, glass is separated into: (a) nonhazardous panel and (b) funnel with lead (Pb). The utilization of cathode-ray tube funnel glass has been promoted as a substitute for sand, while recent studies were focused on the mechanical and durability properties of concrete containing such glass as aggregate. Future products such as precast concrete structural interlocking blocks could contain cathode-ray tube funnel glass aggregate and in case their lead content is high, then they could be classified as hazardous waste.

The aim of the present manuscript was to review the methods of cathode-ray tube glass recycling and to evaluate the potential risks for the utilization of funnel glass in interlocking concrete blocks. The critical evaluation of published literature data will help the development of new product methods through recycling.

Keywords: cathode-ray tube; funnel glass; waste recycling; concrete block

A SYSTEM DYNAMICS MODEL FOR SMALL HOUSEHOLD APPLIANCES' WASTE MANAGEMENT: A CASE OF TURKEY

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Abstract

Nowadays sustainability is one of the most important subjects in the developing world. Thanks to sustainability, waste management also gains more importance. Waste management is composed of many sub-areas in which liquid, gas or solid wastes are treated. The waste category that will be studied in this paper is waste of electric and electronic equipment (WEEE) under solid wastes. Turkey is a country whose household appliances sector is outstandingly large. Furthermore, many small household appliances are thrown away or destroyed due to end of life or quality issues. Most of those wastes do not go through any treatment process even if Turkey has collection and recovery targets for all WEEE categories. As they are not properly treated, the process to destroy without reusing or recycling them causes environmental damage.

The aim of this paper is to put forward a system dynamics model for increasing recovery options of waste of small household appliances in electric and electronic sector, which is not treated in an environmentally friendly way. The proposed model provides decrease in environmental damage.

In this model, Anylogic program will be used for the simulation of the proposed system dynamics model. Different scenarios will be conducted to give recommendations on how the whole system works in the case of Turkey.

Keywords: Waste management, System dynamics, WEEE, Sustainable supply chain management

RAPID STABILIZATION OF MUNICIPAL SOLID WASTE IN BIOREACTOR LANDFILLS: PREDICTIVE PERFORMANCE USING COUPLED MODELING

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Abstract

Municipal solid waste (MSW) landfills are one of the major and most preferred waste management options in the United States and many other countries across the globe. The waste in conventional MSW landfills undergoes very slow decomposition due to limited amount of moisture. In this regard, the bioreactor landfills have emerged as an effective waste management option, wherein leachate recirculation/injection is carried out to enhance the moisture levels within the waste thereby facilitating rapid waste decomposition and leading to early waste stabilization. However, in practice the performance of bioreactor landfills has remained inconclusive due to the lack of sound basis for effective design and operation of such landfills. This further stems from the fact that there is a limited understanding of the physical, chemical and biological processes and their coupled interactions on the MSW behavior in landfills. Hence, it becomes imperative to understand the influence of the coupled processes on the overall performance of bioreactor landfills. Several researchers have developed numerical models to simulate landfill systems but only a few models have considered the simultaneous interactions of hydraulic, mechanical, and biological processes in the landfill. In this study, newly developed numerical framework incorporating coupled thermo-hydro-bio-mechanical processes is presented. The numerical model has the ability to predict the spatial and temporal variation of waste temperatures, moisture distribution, gas generation, pore pressures, waste settlement, waste slope stability, and interface shear response in the landfill liner system. The numerical model has been validated with lab-scale and field-scale experiments and could be used to design and operate stable and effective bioreactor landfills.

Keywords: Solid waste management; bioreactor landfills; leachate recirculation; coupled processes; numerical modeling

COLLECTION AND HANDLING OF SHIP WASTE AND CARGO RESIDUES IN GREECE: PRESENT AND FUTURE

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Abstract

Waste streams generated on board ships en route and during cargo operations are governed by the MARPOL 73/78 waste/residues UN Convention; their efficient delivery at shore and final disposal is a Member States obligation. In order to ensure availability and safe delivery to the Port Reception Facilities (PRF), the European Parliament and the European Council adopted the Directive 2000/59/EU on for ship-generated waste and cargo residues, taking into account International Maritime Organization (IMO) measures. The main difference between the MARPOL 73/78 Convention and the 2000/59/EU Directive is that the former focuses mainly on board operations, whereas the Directive regulates shore side activities. Implementation of the MARPOL 73/78 waste/residues Convention and of the Directive 2000/59/EU in Greece, was implemented by the Common Ministerial Decision 8111.1/41/2009; both Directive and Decision are currently under revision. A proposal for a new Directive has been published in January 2018.

The recent EU Regulation 2017/352 establishes a framework for the provision of port services and common rules on the financial transparency of European ports, affecting as well the ship waste handling sector. In Greece, the regulator that ensures application of the regulation in the domain of ports is the Regulatory Authority for Ports (RAL).

The main targets of this work include the presentation of a) the existing state of delivery and shore-side management procedure for ship waste in Greece, b) the service provision market challenges, c) the assessment of environmental friendly processes and d) the regulatory aspects.

Keywords: ship waste; cargo residues; ports; regulation; port reception facilities; MARPOL 73/78

PASSIVE ACID MINE DRAINAGE REMEDIATION USING BOF STEEL SLAG AND SUGARCANE BAGASSE

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Abstract
This research incorporates the use of two regionally available industrial byproducts produced close to the coal mining region in Eastern South Africa to treat acid mine drainage (AMD): steel slag and sugarcane bagasse, i.e., the shredded cane stalk residual after sugar extraction. Basic oxygen furnace (BOF) slag is regionally produced in Newcastle in large quantities and its high alkalinity makes it ideal for neutralizing acids. Kwa-Zulu Natal is home to the South African sugar industry and the high surface area, polysaccharide content and slow breakdown via acid hydrolysis of sugarcane bagasse makes it an ideal host media for sulfate reducing bacteria (SRB). Accordingly, this research explores the viability of remediating AMD in a two-step continuous process combining both materials. BOF slag eluate (generated from a recycle loop) contacted with raw AMD at an Eluate:AMD ratio of 20:1 was used to initially buffer the AMD solution (pH) and precipitate heavy metals in a sedimentation tank to avoid toxic shocking the SRBs in the sugarcane bagasse bioreactor. Overflow from the sedimentation tank was then passed through a packed bed containing sugarcane bagasse inoculated with SRBs as a polishing step to remove sulfate, precipitate metal sulfides and elevate pH to near neutral pH conditions based on a 16.46 h residence time. A portion of the effluent (95%) was recycled through a packed bed of BOF slag to create the eluate for pre-treatment of the raw AMD solution. The AMD used in these experiments was characterized by: pH 2.4; 388 mg/L Al, 4256 mg/L Fe, 426 mg/L Mg, 96 mg/L Mn, 418 mg/L Ca and 15995 mg/L SO_4^{2-}. Operation of the designed process at a laboratory scale treating 1 L/day, has confirmed the buffering of the AMD solution to a pH of between 7 and 8, and the removal of heavy metals and sulfate to levels of below 10 mg/L for Al, Fe, Mg, Mn and <200 mg/L for sulfate. The bench scale system is currently being scaled up for a pilot treatment system to be deployed in February 2018 near Emalahleni, South Africa, about 150 km due East of Johannesburg.

Keywords: BOF slag, Acid mine drainage (AMD), sugarcane bagasse, sulfate reducing bacteria (SRBs)

USE OF SOLID WASTES IN CEMENT PRODUCTS- A REVIEW

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Abstract

Waste management is a major concern towards sustainable development and natural resources savings. In particular, the objectives of worldwide environmental policy are to preserve, protect and improve the quality of the environment, to protect human health and to utilize natural resources prudently and rationally, by retrieving valuable secondary raw materials. Worldwide, researchers are examining the possible utilization of various materials such as End of Life (EOL) Tires, C&D (Construction and Demolition) Wastes and WEEE (Wastes from Electrical and Electronic Equipment), in many applications. Civil Engineering sector can utilize, under specific circumstances, many of those secondary materials for the production of new mixtures based on cement, asphalt or soil either as alternatives to natural aggregates or as additives to the mixtures. Moreover, legislation in force, concerning alternative management of wastes, makes these efforts more urgent, since all European Countries should comply with its demands as far as quantitative and chronicle targets are concerned.

Current paper monitors and evaluates technical knowhow on basic properties of cement products with EOL Tires, C&D Wastes and WEEE gained during the last 24 years worldwide. Properties discussed are workability, specific weight, air content and compressive strength. Laboratory experiments certify that addition of wastes in the production of cement mortars is possible, leading to mixtures with satisfactory characteristics as far as strength and durability is concerned. At the same time environmental protection is achieved by decreasing the huge amount of wastes generated and by increasing natural resources savings.

Keywords: Solid wastes, EOL Tires, C&D Wastes, WEEE, Cement products, Legislation, Strength, Recycling

A WEB-BASED PLATFORM FOR LANDFILL LEACHATE ESTIMATION AND MANAGEMENT

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Abstract

The water balance method was used to develop a landfill leachate management and monitoring software, on behalf of the Regional Association of Solid Waste Management Agencies of Central Macedonia (RAACM). The aim of the software is to monitor and estimate the leachate generation rate in each landfill operating in the region. It can be used retrospectively where no direct flow measurement is possible, and also as a design tool for future leachate management works under different scenarios. A web-based application was selected, since large spreadsheets can be error prone, and to overcome difficulties arising from the large geographical dispersion of the landfills. A monthly step is used for the estimation of the generation rate and the performance of each wastewater treatment plant (WWTP) is evaluated by modeling the hydrologic and hydraulic conditions in each landfill. The innovation of this software is that it estimates leachate generation for landfills that are in operation, when most of the existing tools (e.g. HELP) are for inactive sites.

During the development of the software, a group of assumptions were tested for their influence in the leachate generation rate. According to the results of water balance that was applied to Mavrorachi landfill for the period 2008-2017, separating the landfill in lifts results in leachate generation rates that differ up to 22% from those calculated without separating it. Nevertheless, other parameters, such as the precipitation distribution between different lifts, that are difficult to estimate or collect monthly, affect the calculation of leachate generation rate very little (1-5%).

Keywords: Sanitary landfill, Water balance, Leachate management, Environmental tools, Solid waste management

Protection and restoration of coastal zone and open sea waters

SUSTAINABLE COASTAL ZONE MANAGEMENT OF STRYMONIKOS GULF – IMPLEMENTATION OF THE D.P.S. FRAMEWORK FOR COASTAL ACTIVITIES PRESSURES ANALYSIS

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Abstract
Sustainable management of coastal areas strives for the maximum long-term societal good, including environmental, economic, social and cultural considerations. Coastal zones, as ecologically sensitive areas, are considered as the main location of residential, economic, industrial and touristic development, due to their natural characteristics and the high aesthetic value of their landscape. However, they are vulnerable to pollution by large quantities of organic load, fertilizers and pesticides, urban and industrial wastewater, which eventually end up in the sea, through the aquatic recipients. The application of the D.P.S. (Driving Forces-Pressures-State) Framework, which is a subsystem of the D.P.S.I.R. Framework (Driving Forces – Pressures – State – Impacts – Response), is proposed to the coastal zone of Strymonikos Gulf. It focuses on the identification, assessment and evaluation of potential impacts of coastal activities, such as tourism, industry, agriculture, fishery, etc., by using the appropriate economic, environmental and social indicators, in the context of sustainable coastal zone management. As a result, it is obvious that there is a growing need for the application of such a framework in a coastal zone, which can be used to organize research that increases understanding about interaction between environmental and societal processes, in order to help understand and support as well, sustainable coastal zone management scenarios.

Keywords: D.P.S. framework, Evaluation, Coastal zone sustainable management, Strymonikos Gulf

IMPLEMENTATION OF THE MULTICRITERIA METHOD AHP FOR THE EVALUATION OF STRYMONIKOS GULF MANAGEMENT SCENARIOS WITHIN THE CONTEXT OF INTEGRATED COASTAL ZONE MANAGEMENT

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Abstract

Integrated Coastal Zone Management contributes towards maximizing the environmental, economic and social benefits provided by coastal zones, while minimizing all potential negative impacts of activities upon each other. Coastal areas are of particular interest as they usually include a wide variety of habitats and ecosystems, as well as many important human/economic activities. Human coastal population increases continually and consequently, there is much stress from all settlements and economic activities to coastal zones. A proposed methodological approach for management plans evaluation, in the context of Integrated Coastal Zone Management, is described. Therefore, alternative management scenarios for the examined area of the coastal zone of Strymonikos Gulf, are presented. The selection of the prevailing alternative proposal is made through the process of multi-criteria analysis. More specifically, the method of Analytical Hierarchical Process is applied, so that the suggested alternative solutions are estimated and classified by using economic, ecological and social criteria, in order to contribute positively to Coastal Zone Integrated Management towards sustainability.

Keywords: Multicriteria analysis, AHP, Integrated Coastal Zone Management, Management plans evaluation

MODELLING THE IMPACT OF CLIMATE CHANGE ON COASTAL FLOODING WITH THE USE OF A 2DH BOUSSINESQ MODEL

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Abstract
In the present work, an advanced numerical model based on the solution of the higher-order Boussinesq-type equations for breaking and non-breaking waves is applied in order to simulate the impact of climate change on coastal flooding. The model is tested against two-dimensional (cross-shore) experimental data by Roeber at al. (2010), and is afterwards applied to the area of the Bay of Thessaloniki (northwestern Aegean Sea, Greece) for representative scenarios of climate change-induced wave and storm surge events. Results highlight the model's capabilities and set the basis for a comprehensive evaluation of the use of advanced modelling tools for the design of coastal protection and adaptation measures against future climatic pressures.

Keywords: climate change, coastal flooding, numerical model, Boussinesq equations, wave modelling

ON THE INTEGRATED MODELLING OF WATERSHED-COAST SYSTEMS: CONSIDERATIONS FOR MORPHOLOGICAL MODELLING UNDER A CHANGING CLIMATE

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Abstract

The term Watershed-Coast Systems (WACS), coined by Samaras and Koutitas (2014a), refers to the entities consisting of watersheds of rivers/natural streams and the areas adjacent to their outlets where sediment delivery from the upstream is critical for the balance of the coastal sediment budget, thus playing a key role in long-term evolution of coastal morphology. In the present work, a concise critical review of the existing knowledge on the integrated modelling of WACS' morphodynamics is presented, along with considerations regarding the introduction of the impact of climate change in the above context. This work systemises the theoretical background of this emerging scientific field and highlights the major challenges ahead, setting the basis for a comprehensive evaluation of the methodological approaches used in relevant research with a clear focus on their applicability.

Keywords: Watershed-coast systems, integrated approaches, morphological modelling, climate change

ASSESSING THE RESILIENCE OF THE RIA FORMOSA BARRIER ISLAND SYSTEM: PRELIMINARY FINDINGS

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Abstract

The aim of the present paper is to analyse the recent morphological evolution of the sandy barriers of Ria Formosa, a multi-inlet system located in South Portugal, to assess evolution regimes and related controlling factors and to identify resilience mechanisms in response to natural and artificial drivers of change. The data collected comprise aerial photographs and wave buoy and hindcast time-series, covering the period from the 1950s to 2014. The results show that the barriers have either been growing, or remaining stable. The growth patterns were either promoted by natural mechanisms, or triggered by stabilization works and supported by natural factors (e.g. longshore transport, shoal attachment). The presence of a broad marsh platform in the backbarrier was found to promote barrier stability, while the sustainance of transgressive barriers is advocated by frequent overwash, combined with low depths in the backbarrier lagoon and localised replenishment of sand. These long-term evolution regimes and their relation to artificial and natural factors show that the barriers of Ria Formosa have been resilient during the time-frame of the study, either absorbing disturbances (Armona and Tavira), or adapting to change while maintaining their functions (rest of the barriers).

Keywords: Geomorphology, remote sensing, multi-decadal analysis, ecological resilience

EFFECTS OF CLIMATE CHANGE IN THE PORT OF TRELLEBORG AND PROTECTIVE MEASURES

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Abstract
This paper refers to the effect of climate change on the rise of the sea level, particularly in the south-western Baltic region, at the port of Trelleborg. The port of Trelleborg from 1862 till present has changed and has expanded in terms of its area of activity and in terms of its size, being the second largest port in Sweden and the largest Ro-Ro Port in Scandinavia. Addressing climate change aims to deal with the upcoming ecological disruptions. Although the results of climate change are unknown, potential future climates based on natural principles and greenhouse gas emission scenarios can be projected. Satellite measurements show that the sea level is rising at a steady pace worldwide. In the case of this study, for the mean wave height it was assumed that there would be a greater increase due to the uncertainty about the direction of the waves in the prediction models and the maximum wave height was considered as high due to the more frequent occurrence of extreme phenomena than in the past. The WAVE-L model was used to study 7 possible solutions in order to protect the harbor from the rise of the sea level and to ensure resting conditions. The solutions focus on the number, position and length of floating breakwaters. The choice of the floating breakwater was made as it is a mild method of protection with environmentally friendly character and ability to move and rearrange. Finally, by comparing the individual results for mid and extreme waves, the optimal solution is chosen to adequately protect the port.

Keywords: Trelleborg Port, Climate change, Sea level

EVALUATION OF IMPACTS OF TORRENT CORRECTION WORKS AT FOURKA-HALKIDIKI IN THE COASTAL ZONE OF FOURKA BEACH

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Abstract
The major characteristic of the torrent of Fourka-Halkidiki, one of the most devastating streams of Kassandra peninsula, is the intense flooding behaviour in conjunction with the production and transportation of huge, for its size, sand-composed debris. The formation of Fourka sandy beach, which is a tourist attraction pole, is mainly ought to the stereo-transportation of Fourka stream. The continuous, during the stage of increased supplies, accumulation of sand from Fourka stream combined with the sea-waving, drifting of sand towards the axis of Fourka (NW) → Poseidi (NE) form the shaping causes of Fourka beach. Until recently, in 2010, these two opposite-functioning phenomena (accumulation of sand from the Fourka stream and abduction of sand form the coastal sea sea-waving Fourka → Poseidi), were relatively balanced. After the devastating floods of 1990 and 2006 and the implemented stream correction works, the sand accumulations have been interrupted (practically eliminated) a fact that resulted to the destabilization of existing balance among each other and the shrinkage of coastal zone. In the present paper are recorded and evaluated the impacts of the implemented anti-flood correction works of Fourka's stream upon the movement of the produced sand and the destabilization of the coastal zone at Fourka beach.

Keywords: Fourka stream, stereo-transportation of Fourka stream and flood genesis, sand-accumulation of beaches, Fourka beach

Protection and Restoration of the Environment XIV

Environmental hydrology

COMPARISON OF METEOROLOGICAL DROUGHT INDICES IN THESSALY WATER DEPARTMENT, GREECE

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Abstract

In an effort to capture various aspects of drought which contribute to the intensification of the phenomenon, many indices have been suggested, based on one or more hydro-climatic parameters. In this paper the behavior of four meteorological drought indices with different structure is discussed, analyzing the spatial and temporal characteristics of drought in the water department of Thessaly. More specifically the widely used indices: Standardized Precipitation Index (SPI), Standardized Precipitation-Evapotranspiration Index (SPEI), and two modified multivariate indices based on the Multivariate Standardized Drought Index (MSDI), are selected for a comparative regional drought analysis. The first multivariate index is derived combining probabilistically the hydro-climatic variables of precipitation and potential evapotranspiration, – while the second combining the indices SPI and SPEI. The monthly precipitation and temperature data, covering the hydrological period 1960-2002, were used for the calculation of the considered indices at time scales: 1, 3, 6, 9 and 12 months. In order to obtain equal amount of precipitation and temperature data, the lapse rate method is applied, forming 78 meteorological stations. A time-series analysis and a drought classification for all the stations are performed, presenting the main similarities/differences in the behavior of four indices. Additionally, a correlation analysis is conducted, displaying scatter plots and spatial patterns of correlation values for the possible combinations of the examined indices. SPI and SPEI seem to be the most appropriate indices for the detection of drought episodes in our region. Furthermore, it was ascertained that the indices SPI and SPEI are more strongly correlated in the mountainous regions where the influence of the potential evapotranspiration is not so noticeable.

Keywords: Standardized Precipitation Index (SPI), Standardized Precipitation-Evapotranspiration Index (SPEI), Multivariate Drought Indices; Drought Variability, Thessaly Water Department

RAINFALL TEMPORAL DISTRIBUTION IN THRACE BY MEANS OF AN UNSUPERVISED MACHINE LEARNING METHOD

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Abstract

An unsupervised method that utilizes a combination of statistical and machine learning techniques is presented in order to classify statistically independent rainstorm events and create a limited number of design hyetographs for the Water Division of Thrace in Greece. The whole process includes the necessary steps from importing raw precipitation time series data to producing the initially unknown optimal number of representative design hyetographs. These hyetographs can be used for stochastic simulation, water resources planning, water quality assessment and global change studying. The present type of analysis is applied for the first time on data from a Greek region and, in addition, it presents certain characteristics of a more general applicability. Namely, the method employed is fully unsupervised, as no empirical knowledge of local rainfalls is implicated or any arbitrary introduction of quartiles for grouping. Also, the critical time duration of no precipitation between rainstorm events is not defined in advance, as is the case in the pertinent literature.

Keywords: Rainfall temporal distribution; design hyetographs; unsupervised machine learning; hierarchical clustering; Principal Components Analysis

DEVELOPMENT AND QUANTIFICATION OF VISUAL ANALYTICS ALGORITHMS FOR INVESTIGATING EXTREME WEATHER EVENTS IN TIME-VARYING GEOGRAPHIC DATA

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Abstract

The large amount of measurement data from Greece's meteorological network requires visualization and processing to be more understandable and useful. In this paper we study measurements and forecasts of temperature and wind velocity for the geographical area of Greece and we produce useful depictions through an interactive application. We also include statistical processing on the wind data so that we can understand in which area of Greece there is a greater probability of extreme weather events occurring. In general, Visual Analytics may help the emerging area of Artificial Intelligence and Decision Support Systems. The data used in this work is obtained from the National Observatory of Athens through the site of meteo.gr.

Keywords: Measurements, Temperature, Wind Data, Extreme Weather Forecasts, Decision Support Systems

DEVELOPING FLOOD ACTION PLANS ON THE ADMINISTRATIVE LEVEL OF FARMERS' ORGANIZATION

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Abstract

Agriculture constitutes one of the most vulnerable sectors on floods impacts, the frequency and severity of which are expected to increase within the context of climate change. Despite the fact that floods' action plans are commonly developed on national or regional level, it is important for each water resources "key player" within a basin to compile local and case specific action plans in order to increase its adaptability to the corresponding impacts and sufficiently contribute to floods management in the basin. This necessity is also addressed by the business-oriented water management certification schemes (e.g. the European Water Stewardship Standard), according to which management of such incidents are of major importance.

Taking into account the above, this paper aims to introduce a simplified approach for the compilation of flood action plans in Farmers' Organization (F.ORs), which constitutes a common organizational scheme of agricultural production in the Mediterranean. The first step is to assess the risk of: a) river floods, based on flood risk assessment reports developed within the context of Floods Directive by EU and b) flash floods, based on surface runoff potential estimated by a simplified methodology incorporating spatially distributed runoff curve numbers, ground slope and precipitation. The second step is to propose practices and actions in order to: a) contribute to basin's flood risk reduction and b) mitigate the impact of flood incidents. The above mentioned methodologies are applied in the area of activity of a F.OR located in Crete Island, Greece.

Keywords: floods, droughts, agricultural water management, curve number, good agricultural practices

MODERN MAPPING TECHNOLOGIES FOR MORPHOMETRY DYNAMICS OF KERKINI RESERVOIR

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Abstract
In a lake ecosystem environment or a reservoir system, the knowledge of some basic parameters, such as the morphometry of the lake, the basin and the distribution of physical, chemical and biological parameters is very crucial. The determination of these parameters is fundamental in the implementation of a management plan for the protection and restoration of lakes and reservoirs. This paper investigates modern mapping technologies such as GNSS/GPS and sonar systems, for the estimation of morphometric parameters, as the bottom relief, the hypsographic curves, the volume-heights tables and also the calculation of the deposition rate of sediments in a reservoir. The latter is a particularly critical problem in reservoirs where hydroelectric plants operate. At the same time, the paper examines a mapping method, alternative to traditional techniques, faster and significantly more economical, making a management plan viable. It is the method of satellite bathymetry, which is based on the extraction of depths, using information from the spectral bands, of a satellite image. For this purpose, the multi-spectral image of the Worldview-2 satellite is being used. In both mapping techniques (hydrography and satellite bathymetry), all the necessary reliability checks are implemented and the comparison between them, lead to conclusions about the use and applicability of each method. The Kerkini reservoir is the case study, where all these methods and techniques are applied. The aim of this paper is to describe and propose reliable mapping techniques that contribute to the efficient management of water systems such as the Kerkini reservoir.

Keywords: Morphometry, GNSS/GPS, satellite bathymetry, reservoir management

Protection
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XIV

Ground water resources management

BUILDING GROUNDWATER CONCEPTUAL MODELS UNDER LIMITED INFORMATION SUPPLY: A CASE STUDY ON AXIOS DELTA, NORTH GREECE

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Abstract

Poor hydrogeological conceptualisation can have adverse effects on the accurate representation of flow processes simulated by numerical models. This work explores the idea of conceptual model building in complex settings with limited spatiotemporal information supply. The case study of the eastern coastal aquifer in the Axios Delta area is examined, where ecological, irrigation and urban water supply demands exert pressure on local water resources. The water demands are covered by the exploitation of surface water and groundwater resulting in a decrease in river flow over the last decades and the salinization of Axios Delta area. The Delta is currently under the environmental responsibility of numerous agencies which have available data according to their specific activities. A detailed step-by-step data collection was performed including lithological profiles, water level measurements, river abstractions, climatological data, geological and geomorphological maps. In this context, a conceptual model accounting for surface-subsurface interactions, recharge processes and human interventions is developed to support hydrogeological modelling for evaluating risk of saltwater intrusion and long-term sustainability of the ecosystem under climate change scenarios. Further uncertainty is introduced by the complex nature of the deltaic deposits. Confidence in the conceptual model is discussed and how it propagates through to the simulation predictions. The numerical model will inform systematic monitoring recommendations on an ease-of-implementation basis to improve confidence. This can have implications on improving the understanding and overall resilience of the deltaic ecosystem resource as supported by international policies. The establishment of the hydrogeological conceptual model in this area could be the base of an integrated monitoring plan, which is essential for a rational water management in the coastal zone.

Keywords: Coastal zone; Conceptual modelling; Hydrogeological model; Uncertainty management; Saltwater intrusion; Climate change

INVESTIGATING GROUNDWATER FLOW AND SEAWATER INTRUSION IN NEA MOUDANIA AQUIFER UNDER VARIOUS MANAGEMENT SCENARIOS

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Abstract
Many coastal areas all over the world face significant water availability issues due to population increase and numerous human activities (i.e., tourism development, commercial and agricultural activities) taking place in the interior of them. This problematic situation becomes even worse when groundwater resources constitute the sole source of freshwater. Moreover, coastal areas are threatened by seawater intrusion caused due to the substantial decline of groundwater levels. To this task, the implementation of various protective countermeasures, that should be carefully examined and evaluated, is often required in these regions. For this reason numerical modeling is usually applied, since it enables studying the spatial and temporal evolution of both hydraulic head and seawater encroachment under different management perspectives. Within this framework, the present study investigates the implementation of various management scenarios aiming at dealing with both groundwater drawdown and seawater intrusion in the coastal aquifer of Nea Moudania, Halkidiki, Greece, which faces both considerable decrease of groundwater levels and increased salinization due to seawater intrusion. All management scenarios are actually related to the reduction of pumping rates of the abstraction wells (irrigation and/or domestic wells) due to the implementation of pumping restriction measures or the exploitation of alternative water resources (i.e. use of surface water). The investigation and evaluation of the alternative scenarios are performed through the application of a calibrated transient groundwater flow-solute transport model already developed for the reference area, by studying the spatial and temporal evolution of both hydraulic head and chloride concentrations resulting from each scenario.

Keywords: groundwater drawdown; seawater intrusion; groundwater resources management; numerical modeling; Nea Moudania aquifer

SPATIOTEMPORAL GEOSTATISTICAL MODELING OF AQUIFER LEVELS USING PHYSICALLY BASED TOOLS

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Abstract

Spatiotemporal geostatistics is a significant tool for groundwater level modeling and resources management. Geostatistics is complementary to the physical models which are based on partial differential equations that govern the flow and transport of pollutants in the groundwater. However, physical models require significant amount of data for calibration (e.g., boundary conditions, estimation of the hydraulic conductivity statistics and spatial correlation). In the case of sparsely monitored areas the number of available data often does not support the use of physical models, which makes a statistical stochastic approach necessary. Researchers in the field of hydrology investigating the variability of aquifer properties are often involved in cases with scarce spatial and temporal data. In such cases, modeling of the groundwater level as a random field, which can be analyzed and estimated by means of geostatistics, is an alternative accessible option. Thus, it can be implemented with fewer measurements and is computationally less complex than the solution of partial differential equations. A recently developed non-separable physically based covariance function is appropriately modified employing tools of physical meaning to enhance the efficiency and reliability of spatiotemporal geostatistical modeling in groundwater applications. The proposed covariance function is mathematically valid (i.e., constitutes permissible models), and provides a useful tool to model scarce space-time groundwater level data. Herein, the efficiency of the proposed tools is tested using groundwater level data from an alluvial unconfined aquifer.

Keywords: non-separable covariance; space-time interpolation; space-time modelling, groundwater; sparse data

COST MINIMIZATION OF INTERMITTENT TRANSIENT GROUNDWATER PUMPING

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Abstract

In this paper, consideration is being given to minimizing the pumping cost from a system of wells under transient groundwater flow conditions in a confined aquifer.

In particular, previous work has been extended to include cases of intermittent pumping in both infinite and semi-infinite aquifers, where the method of images applies.

The mathematical method used to find the minimum of the cost function was the Lagrange multipliers.

It has been proved analytically that at any time, the pumping cost is minimized when the hydraulic head level drawdowns at the locations of the wells are equal to each other.

Keywords: Optimization, method of images; Lagrange multipliers, pumping cost, groundwater management

STUDY ON GROUNDWATER NITRATES IN THE NORTHWEST OF THE THESSALONIKI REGIONAL UNIT (GREECE)

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Abstract

The present study deals with the issue of local high nitrate ion concentrations in the groundwater of the Greek region of Mygdonia. The specific phenomenon can be of great importance to Mygdonia due to health effects described in literature and a possible reduction of crop yield, a major concern for the regional agriculture-centred economy. Nitrate concentrations were measured in samples collected from a multitude of locations in all three settlements of the region. Concentrations exceeding the 50 mg/L EU limit were found in the majority of locations, especially around the area of the plains of Mygdonia (settlements Drymos and Lete). This result was followed by statistical analysis of past measurement data, which confirm chronically high levels in these locations as opposed to the more mountainous area where acceptable concentrations were observed. Furthermore, slight rising linear trends were calculated in locations of high nitrate concentrations and minimal negative trends in those of lower concentrations.

A phytotoxicity screening of species *Sorghum saccharatum* and *Sinapis alba* in the presence of high nitrate content water was also conducted, indicating a significant hindrance of early plant growth. Thus, crop cultivation may also be at risk due to nitrate presence in groundwater used for irrigation. Finally, probable causes are discussed and compared to previous studies, wherefrom an obvious pattern of correlation to agriculture and N-fertiliser application arises; the region-specific hydrogeological profile, however, also significantly raises the risk of groundwater contamination. Specific handling suggestions for facing the nitrate problem are discussed in this study.

Keywords: Groundwater nitrates, Mygdonia aquifer, Phytotoxicity, N-fertilisation effects, Nitrate vulnerability

SIMULATION OF WATER FLOW IN THE UNSATURATED SOIL ZONE TO ASSESS IRRIGATION IN A MAIZE FIELD

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Abstract
Accurate estimation of the hydrological features in the unsaturated zone is mandatory for the effective planning of irrigation strategies. Irrigation scheduling depends on crop and soil type as well as climatic characteristics and is usually empirically conducted. This paper simulates the water flow in the unsaturated zone of an agricultural field located in the River Strymonas basin using the HYDRUS-1D model. The model is fed with meteorological data, soil data and soil moisture measurements derived by field experiments. After the calibration of the model, model results were used to evaluate the irrigation activities applied in the experimental field in terms of irrigation dose, irrigation interval and soil moisture variation for the cultivation period.

Keywords: Vadose zone simulation, HYDRUS-1D, Maize, Irrigation

Protection and Restoration of the Environment XIV

Climate change impacts and adaptation measures

LAND-USE CHANGE ROLE IN CLIMATE CHANGE MITIGATION GOALS ACHIEVEMENT

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Abstract

Land use, land-use change and forestry (LULUCF) sector plays an important role in climate change mitigation and is a key element in Paris agreement. Long-term goal of carbon neutral economy in second half of this century depends on LULUCF ability to sequestrate greenhouse gases (GHGs) emissions in biomass and soil. With reference to the Paris Agreement, accounting rules of GHG emissions and removals in LULUCF sector has been heavily discussed recently in the European Union, seeking of trustworthy inclusion in the assessment of Union's GHG emission reduction target. Therefore, paper aims to analyze Lithuanian situation regarding LULUCF sector and total GHG balance from the climate change perspective. For this, changes in greenhouse gas emissions and removals in Lithuania have been studied during years 1990 - 2015. Lithuania's total GHG emission balance has changed significantly since 1990, with more than twice decreased emissions till 2015. LULUCF sector absorption was increasing since 1990 and was equal around 1/3 of total country emissions in 2015, removals were mainly composed of carbon sequestration in forest land. However, mainly the basic level of estimations (Tier1 methodological level) is applied currently for GHG absorption and emissions potential. Therefore, more exact emission factors and other possible determinants (biomass demand for energy purposes, energy efficiency, economic growth) of LULUFC potential should be analyzed in more detail in order to make corresponding and sound political decisions.

Keywords: Land-use change; GHG inventory; sequestration; emissions; removals; climate change mitigation; policy achievement

CLIMATE CHANGE ADAPTATION STRATEGIES IN GREECE: RECENT DEVELOPMENTS AND TRENDS

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Abstract

In recent years, climate change policies have put special emphasis on climate adaptation strategies, alongside climate mitigation strategies, in an effort to address the inevitable impacts of climate change. Many European countries have proceeded with the elaboration of adaptation strategies at the national, regional and local levels, while many cities have prepared their adaptation strategies or have incorporated adaptation options into their spatial planning strategies. The sustainable development principles as well as the risk management approach have largely determined the character of these strategies. At the same time, of key importance are the spatial dimensions of climate adaptation strategies, since climate change impacts are territory-specific and are mostly addressed at the local and regional levels.

In Greece, climate change mitigation is included in the targets set by the country's strategy for sustainable development launched in 2002. Provision for the country's National Adaptation Strategy (NAS) was first made in line with its EU cohesion policy and climate policy commitments and has been ratified in 2016. Subsequently, the specifications of the regional plans for climate adaptation have been prepared by the competent ministry, in order to promote the elaboration of such plans.

This paper seeks to examine the above-mentioned developments in the field of climate change adaptation in Greece. It examines the character of the NAS as well as the emerging characteristics of the regional plans for climate adaptation, especially in relation to sustainable development principles and the risk-management approach. Particular emphasis is placed on the spatial dimensions of the plans which are considered critical for both the implementation of plans and their linking with spatial planning at the local and regional levels.

Keywords: Regional adaptation strategies, Climate adaptation strategies in Greece, Spatial planning

SPATIAL ANALYSIS FOR VULNERABILITY ASSESSMENT OF URBAN COASTAL AREAS TO SEA LEVEL RISE

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Abstract
It is widely accepted that climate change poses a potential threat for urban environments, thus is one of the largest challenges for humanity nowadays. The most common effect of climate change is the Sea Level Rise (SLR), which develops in the long run and is directly connected to extreme weather conditions at the coastal zone level. Coastal zones are most affected by extreme weather phenomena caused by SLR. The understanding of the potentially dire impacts of climate change has resulted in the widespread use of the resilience concept. This study examines methods of spatial analysis that can introduce the variable of climate change to the landscape architecture analysis with the intention to enhance resilience in the design process. The study reports the results of the application of a methodology for the assessment of the vulnerability of coastal areas to SLR due to climate change. It also allows identifying critical areas to this phenomenon and providing a useful classification of the coastal areas in the selected study areas. Introducing Geographical Information System (GIS) techniques and spatial analysis, the study approaches a methodology of determining coastal zone vulnerability for Thermaikos and the Corinthian Gulf. Both case studies are vulnerable due to accelerated SLR, high erosion rate that threatens urban areas and protected ecosystems on the coastal zone. For the determination of the Coastal Vulnerability Index (CVI) geologic and physical variables were considered. The CVI is giving results towards an evaluation of the likelihood that physical changes may occur. The study attempts to introduce resilience on the coastal zone by identifying the most vulnerable areas to SLR and consider them as an indispensable support for landscape architecture projects and spatial intervention.

Keywords: Resilience, SLR, Coastal zone, Soft infrastructure, GIS, Spatial analysis, CVI

REFERENCE EVAPOTRANSPIRATION ASSESSMENT IN CHALKIDIKI REGION UNDER CLIMATE CHANGE USING FOUR EARTH SYSTEM MODELS

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Abstract
Reference evapotranspiration (ET_o) is an important component in water resources, agricultural and environmental modeling. Thus, the assessment of ET_o changes in response to future climate change has a great impact in agricultural sector. In this study, the effect of climate change on reference evapotranspiration in Northern Greece, was assessed. For this purpose, the climate change scenario RCP4.5 based on four Earth System Models (ESMs) CanESM2, GFDL-ESM2M, HadGEM2-ES and IPSL-CM5A-LR was used for the time period 2081-2100 and for the baseline period (1981-2000). The downscaling was performed using the weather generator ClimGen. Reference evapotranspiration was estimated with the use of the FAO Penman-Monteith equation. Results showed that mean annual reference evapotranspiration is projected to increase (from 6% up to 25%) in response to climate change during 2081-2100 according to the four ESMs. Regarding reference evapotranspiration of the irrigation period (May to September), the increase will be similar to annual, ranging from 5% to 27%. The results indicate that the development of adaptation strategies is necessary for the improvement of agricultural water management and the reduction of climate change impacts on agriculture.

Keywords: Climate change, Reference evapotranspiration, RCPs, Earth system models, ClimGen

ASSESSING THE TEMPERATURE CHANGES OVER EUROPE FOR THE 21ST CENTURY USING A REGIONAL CLIMATE MODEL

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Abstract
In the framework of the 7th FP project REQUA-“Regional climate-air quality interactions”, we assessed climate change for the 21st century over Europe. Five regional climate modelling systems from the Euro-CORDEX initiative were used, covering the time period from 1986 to 2100 with a spatial resolution of 50 Km. The selected future scenario was the Representative Concentration Pathway RCP8.5. The regional climate model simulations were forced by different Global Climate Models and compared to available observational data, to estimate the models’ biases. The analysis highlights the ability of regional climate models to properly simulate the European climate as well as an expected average temperature increase for Europe until the end of the 21st century. Temperature trends are estimated to be higher in southern Europe mainly in the summer. Geospatial information on climate change is extremely useful for studies focusing on the impact of climate change on different sectors including protection of the environment, adaptation and mitigation policies.

Keywords: Climate models, Euro-CORDEX, Climate projections, Climate change

CLIMATE CHANGE IMPACTS ON THE COASTAL SEA LEVEL EXTREMES OF THE EAST-CENTRAL MEDITERRANEAN SEA

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Abstract

Extreme events of sea level elevation, due to severe weather conditions, pose great threats to low-land coastal areas by extended inundation hazards. The latter take the form of short- to mid-term flooding due to wave- and storm-induced sea level elevation and run-up on the coast. In this paper, the impact of the combined effect of extreme storm surges and extreme wave set-up in nearshore areas is investigated. The framework is set by future and historic climate change scenarios during a period of 150 years (1951–2100) that affect the occurrence frequency and magnitudes of total (surge- and wave-induced) sea level extremes in the eastern Mediterranean, focusing on the coastal zones of Greece. Inter-annual and multi-decadal patterns, trends and return levels of storm surge and wave set-up extremes are calculated based on non-stationary bivariate statistical analysis with copula functions of the Generalized Extreme Value distribution. The numerical data of storm surge- and wave-induced sea levels are derived from post-processing of simulation results by GreCSS and SWAN models, respectively, in order to transfer validated numerical data from offshore regions towards the shoreline of selected areas prone to coastal flooding. An increase and a consequent attenuation of storminess and inter-annual extremes of total sea level on the coast is estimated during the 1st and 2nd half of the 21st century, respectively. Different morphological characteristics of regional coastal zones in the Aegean Sea are found to influence variability of sea level extremes.

Keywords: Storm surge, Wave set-up, Extremes, Mediterranean Sea, Climate change impact



Protection and restoration of ecosystems

BIOFILM GROWTH IN DRINKING WATER SYSTEMS UNDER STAGNANT CONDITIONS

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Abstract

Safe drinking water is essential for human health and its provision in a changing climate is a global pressing problem. Research communities, governments and drinking water supplying companies are working on improving the quality of drinking water and reducing its cost. Microorganisms colonise the inner surfaces of pipes and form biofilms. In drinking water systems biofilms are problematic as they cause loss of disinfectants, harbour pathogens and affect the aesthetics of drinking water. From the engineering perspective, that leads to corrosion of the pipe's material and reduced life of the existing infrastructure. Thus, it is imperative that we gain a deeper understanding of the growth of biofilms if we are to develop effective strategies for their removal or control.

In this study we focused on the growth of biofilms in drinking water under stagnant conditions, which often occur in parts of drinking water pipes. A bioreactor was used to simulate the service lines of drinking water systems. After 4 weeks, the thickness and density of the biofilms were characterised using gravimetric measurements, and their surface area was determined using fluorescence microscopy. Also, the concentration of cells and microcolonies both in the bulk water and on the reactor surfaces was determined using fluorescence microscopy. Finally, spatial statistics were used to describe the biofilm structures that were formed on the exposed surfaces of the reactor. It was revealed that even under stagnant and oligotrophic conditions, drinking water bacteria moved from the bulk water of the reactor and attached to the available surfaces forming a high number of microcolonies. Biofilms were able to grow on the exposed surfaces of the reactor forming characteristic structures consisting of dense cell clusters. Our results revealed that even under unfavourable conditions biofilms can grow within our drinking water systems.

Keywords: biofilms; drinking water; microscopy; reactor; stagnant

RESTORATION OF TWO GREEK LAKES (KASTORIA AND KORONIA): SUCCESS STORIES?

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Abstract
Lake Kastoria and Lake Koronia, both shallow (maximum depth 8-9 m) and large lakes (29 and 45 km^2, respectively) of Greece, 50 years ago, have undergone heavy degradation by human activities over the past decades. Since 2002, Koronia became a temporary lake due to a dramatic decrease in surface area and depth owing to unsustainable water management. During the last two decades, efforts have been made for the restoration of both lakes based on programmes of measures. In this work we present the long-term phytoplankton changes in the lakes under restoration aiming to identify a) critical changes in target phytoplankton attributes set for ecological restoration and b) success in ecological water quality improvement. Following 23 years of sewage diversion in Kastoria and the last two years' adjustment of the lake's water level through flushing, all phytoplankton metrics (species composition, phytoplankton biomass, cyanobacterial biomass, *Microcystis* biomass) indicate partial success in community restoration and an obvious water quality improvement. The dominance of several non-harmful and good quality species of the genera *Ceratium*, *Fragillaria*, *Dinobryon*, *Mallomonas*, *Cryptomonas*, *Rhodomonas* and *Nitzschia* indicates species recover, however not complete, opening ecological processes restoration. In particular, after the episode of a heavy toxic cyanobacterial bloom (with *Microcystis* dominating the phytoplankton community) in 2014, the implementation of the flushing tool in 2016 - 2017 resulted in phytoplankton and cyanobacterial biomass decrease and temporal restriction of harmful species. On the other hand, in Lake Koronia, after the metaphyton dominance in the first years following the lake's re-flooding (2010) the phytoplankton "seed-bank" species ruled over. During 2015 -2017, phytoplankton biomass comprised of a mixture of phytoplankton species recruited from the sediment, which dominated in the lake water since 2003. Specifically, in 2015-2017, the composition and species dominance were almost identical with those of the recently re-generated Lake Karla, known for its bad water quality and the recurrent episodes of fish and bird kills. Co-occurrence of the potential toxic, "seed-bank" species *Anabaena aphanizomenoides* /*Aphanizomenon favaloroi*, *Prymnesium parvum*, *Planktothrix* sp., *Anabaenopsis elenkinii*, *Arthrospira fusiformis*, *Cylindrospermopsis raciborskii* and *Pfiesteria piscicida* was recorded in Koronia in 2017. Based on the results of the present study, Lake Kastoria improved to a moderate quality in 2017 while Lake Koronia was characterized by a bad water quality the same year. This study is useful for the decisions involved in water quality management and implementation of the restoration programmes in both lakes.

Keywords: Lakes Kastoria and Koronia, ecological restoration, water quality, phytoplankton

EFFECTS OF CLIMATE CHANGE ON GROUNDWATER NITRATE MODELLING

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Abstract
This paper investigates the impacts of climate change on groundwater quality at the eastern hydrogeological basin of Thessaly in Greece. A modelling system has been applied, consists of General Circulation Model for estimating the precipitation and temperature changes, a surface hydrological model (UTHBAL) for the simulation of the surface hydrological processes and the estimation of the groundwater recharge, a groundwater hydrological model (MODFLOW) for simulation of groundwater flow and finally a transport and dispersion model of examining the nitrate fate and transport under different climate changes. The analysis was conducted for two future periods, a medium term period 2030–2050 and a long term period 2080–2100 examining three different socioeconomic scenarios SRES (A2, A1B and B1). Concerning the results, nitrate concentration in groundwater is likely to increase due to the reduction of groundwater recharge forced by climate change impacts on surface hydrology processes since the agricultural practices does not change.

Keywords: Climate change, water resources management, nitrate contamination, nitrate modelling

AN ASSESSMENT APPROACH TO INVESTIGATE CLIMATE CHANGE IMPACTS IN CHANIA GROUNDWATER SYSTEM

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Abstract
Prolonged dry periods observed during the past years and intense groundwater abstraction for irrigation purposes have raised awareness on groundwater resources management in many agricultural areas. Climate change is expected to increase the frequency of extreme dry periods and groundwater systems recharge will be seriously affected.

The present study emphasizes on the investigation of climate change impacts on groundwater availability in Chania plain groundwater system. Chania plain is considered one of the most important agricultural regions in Crete, where groundwater is the prime source used for irrigation. Intense irrigation needs put pressure on the groundwater system, especially during the dry period (April-September), when the water table is lowered by around 3.5 m. Groundwater flow simulations for the area, using climatic projections for meteorological variables produced by the RCA4 Regional Climate Model of the Swedish Meteorological and Hydrological Institute (SMHI) driven by the Max Planck Institute for Meteorology model MPI-ESM-LR, forced by the IPCC RCP 4.5 and 8.5 scenarios, have shown an additional decrease of the water table of approximately 4 m, during the dry period of predicted dry years.

Keywords: Groundwater system recharge, IPCC scenarios, MODFLOW, Irrigation water

SALINITY EFFECTS ON DIFFERENT VARIETIES OF AMARANTUS SP.

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Abstract

Amarantus sp. is recognized as a promising plant species due to high nutrition value and resistance to adverse environmental conditions. Due to C4 photosynthetic pathway, amaranth can be grown under elevated salinity or water deficit. As salinity is one of the most serious and continuously increasing limiting agents in agriculture, investigations of resistant, high productivity and nutritional value agricultural crops is of particular importance. The aim of this study was to investigate and to compare the resistance of 3 Lithuanian genotypes of Amaranth ('Raudonukai', 'Rausvukai' and 'Geltonukai') to increased salinity. Pot experiments were conducted in growth chambers, plants were exposed to 50 and 150 mM NaCl levels. Seed germination, shoot growth and photosynthetic rate were investigated. At the earliest growth stage 'Raudonukai' demonstrated the highest resistance, germinating 2-3 fold better as compared to other varieties. In contrast, growth of aboveground biomass of 'Raudonukai' was the most seriously affected (up to 54% decrease), followed by 'Geltonukai' and 'Rausvukai'. Leaf area decreased similarly in all varieties, slightly higher effect was characteristic for 'Rausvukai'. The photosynthetic rate declined for all plant species with increasing salinity and exposure time. 50mM salinity level had no impact on photosynthetic performance. The strongest effect for 'Rausvukai' and 'Raudonukai' was observed after 10 days of exposure to 150 mM (up to 33% and 24% inhibition, respectively), followed by adaptation and recovery to control level after 15 days of exposure. Similar reduction of photosynthetic rate was detected for 'Geltonukai', however, photosynthetic adaptation was not observed. Results of this study have shown that Amaranth can be classified as salinity resistant crop species, as vegetative growth and photosynthetic performance were not significantly affected by relatively high (50mM) NaCl concentrations. The negative effects of salinity depended on the growth stage of variety of Amaranth. The most resistant variety at germination growth stage and with respect to photosynthetic performance was 'Raudonukai', followed by 'Rausvukai' and 'Geltonukai'.

Keywords: Amarantus sp., Soil salinity, Stress resistance, Germination, Photosynthetic rate

"DIRTY" SEA PHENOMENON IN THESSALONIKI BAY: PLANKTON ABETTORS AND PERPETRATORS

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Abstract

The "dirty" Sea phenomenon, mentioned also as the mucilage phenomenon in the literature, is caused by the accumulation of gelatinous organic material at and below the water sea surface. The organic material tends to be whitish when young, becoming progressively darker with age. This phenomenon was conspicuous in large extent in Thessaloniki Bay during June 2017. Plankton samples from 3 stations in Thessaloniki Bay were examined before (end of May 2017), during (late June 2017) and after (early July 2017) the phenomenon in order to identify the possible abettors and perpetrators members of plankton. Before the appearance, plankton community consisted of known mucilage producing species such as the autotrophic common diatoms in the Bay *Cylindrotheca closterium, Leptocylindrus minimus, Leptocylindros danicus*, *Skeletonema costatum*, the rare dinoflagellate *Gonyaulax* cf. *fragilis* and the common heterotrophic *Noctiluca scintillans* with its rare relative *Spatulodinium pseudonoctiluca*. These heterotrophic dinoflagellates were responsible for common red tides in the Bay. In May, among the diatoms high abundances were recorded for *Leptocylindros minimus* (26282 cells mL^{-1}), *Dactyliosolen fragilissimus* (866 cells mL^{-1}), and *Cylindrotheca closterium* (168 cells mL^{-1}), while for the heterotrophs high abundance was recorded for the large-sized *Noctiluca scintillans* (0.5 cells mL^{-1}, reaching 5 cells mL^{-1} in the next days). During the phenomenon large mucilage macroaggregates, dead cells of the above mentioned species and alive specimens of the dinoflagellate *Gonyaulax* cf. *fragilis* (68 – 330 cells mL^{-1}) and the diatom *Cylindrotheca closterium* (93 – 393 cells mL^{-1}) were recorded in the "dirty" water. Very abundant mucilage producing species *Skeletonema costatum* (maximum abundance 12454 cells mL^{-1}), *Chaetoceros* spp. (max 10408 cells mL^{-1}), and *Cylindrotheca closterium* (max 1064 cells mL^{-1}) were observed few days later in the "clean" water after the "dirty" Sea phenomenon, which decayed after strong winds, opposed to the rare occurrence of *Gonyaulax* cf. *fragilis* (18 cells mL^{-1}).

Keywords: mucilage, plankton, Thessaloniki Bay, diatoms, *Gonyaulax* cf. *fragilis*, *Noctiluca scintillans*

MONITORING THE MARINE ENVIRONMENT OF THERMAIKOS GULF

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Abstract
In this study, the quality of the marine environment of Thermaikos Gulf was appraised by measuring physical, chemical and biological parameters of the water column and the seabed. Water and sediment samples were seasonally collected from three sampling stations located at the inner part of Thermaikos Gulf. Specific physical-chemical characteristics (temperature, salinity, density along with pH and dissolved oxygen) throughout the water column were evaluated by conducting in situ measurements during the sampling campaigns. In situ processing of the water density data enabled the determination of the water column stratification. Afterwards, water samples were collected from the different strata: surface, pycnocline and bottom, to assess relevant variations of the chemical and the biological characteristics of the water masses. The studied chemical parameters included ammonium nitrogen, nitrites, nitrates, phosphates and total phosphorus and the biological ones phytoplankton and protozooplankton species composition, abundance and biomass. Sediment samples were collected with a standard VanVeen grab from each sampling station. Benthic organisms (macro-invertebrates) were sorted, enumerated under major taxa, and identified up to species levels to assess ecological quality status applying the BENTIX biotic index. Sediment composition and organic content were also assessed. The obtained results are discussed with regards to seasonal and spatial variability and water column stratification.

Keywords: Thermaikos Gulf, monitoring, nutrients, phytoplankton, protozooplankton, benthic organisms

INVESTIGATION OF QUANTUM DOTS TOXICITY, GENOTOXICITY, CYTOTOXICITY, AND UPTAKE IN RAINBOW TROUT *ONCORHYNCHUS MYKISS* LARVAE

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Abstract
Nanoparticles may be released into the environment and induce harmful effects to the aquatic ecosystem. The aims of the present study were to determine: (1) toxicity, genotoxicity and cytotoxicity to larvae of rainbow trout *Oncorhynchus mykiss* exposed to 4 nmol/L CdSe/ZnS quantum dots (QDs); (2) Cd accumulation; (3) the concentration of metallothionein (MT) in larvae after exposure to QDs; and (4) explain the possible impact mechanism of the QDs to fish larvae. QDs at sublethal concentration was used during the tests. Our findings revealed that heart rate (HR, counts/min) of larvae didn't differ significantly ($p < 0.05$) from the control; gill ventilation frequency (GVF, counts/min) significantly ($p < 0.05$) increased only after 10 days of exposure to QDs compared to the control. Total genotoxicity level (erythroblasts with micronuclei and nuclear buds) in larvae significantly ($p < 0.05$) increased after 4 days of exposure. However, 4 nmol/L QDs did not induce significant cytotoxicity over the concentration applied. QDs induced a significant increase in Cd accumulation in larvae after 4-10 days of exposure in comparison with the control. MT was used as a marker of internal Cd exposure, thus providing indirect information on *in vivo* QDs degradation. The concentration of MT did not change in larvae during treatment. Therefore, QDs were stable during 10 days of exposure. QDs absorption was not found to take place in larvae. Possibly, the effects of QDs to larvae are related to mechanical impact of QDs.

Keywords: quantum dots; fish; accumulation; toxicity, genotoxicity and cytotoxicity; metallothioneins

ERYTHROCYTIC NUCLEAR ABNORMALITIES, DNA DAMAGE, BIOCONCENTRATION FACTOR AND HEMATOLOGICAL CHANGES INDUCED BY METAL MIXTURE AT ENVIRONMENTALLY RELEVANT CONCENTRATIONS IN *RUTILUS RUTILUS*

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Abstract
The aim of this study was to assess bioconcentration factor (BCF), metallothioneins (MT), genotoxicity, cytotoxicity and changes of haematological parameters in roach *Rutilus rutilus* after 14 days treatment with a six metals mixture (MIX) at environmentally relevant concentrations (Zn – 0.1, Cu – 0.01, Ni – 0.01, Cr – 0.01, Pb – 0.005 and Cd – 0.005 mg/L) and with 6 variants (reduced concentration of single metal while other metals concentration remain constant) of the MIX. Most frequently the highest accumulated amount of metals in tissues (gills, liver, kidneys, muscle) was detected after treatment with variants of MIX. Significantly reduced concentration of accumulated Ni was measured after Cu↓, Cr↓, Pb↓ and Cd↓ treatments (10 times reduced Cu^{2+}, Cr^{6+}, $Pb^{2+}$and Cd^{2+} concentration, respectively) in all tissues (except in liver after Cu↓, Cr↓ and Cd↓ treatments) compared with MIX. Significant *induction* of *MT in liver and kidneys* was *not detected. However, positive correlation* (r = 0.83; p = 0.022) *was measured between MT and Zn amount in liver.* DNA damage in erythrocytes of roach was examined by comet assay. Additionally, erythrocytic nuclear abnormalities were assessed in erythrocytes of peripheral blood, liver, kidneys and gills. Significant DNA damage was measured after Cr↓, Pb↓ and Zn↓ treatments. Significant elevations in total ENAs were measured after Cr↓ and Ni↓, MIX or Ni↓ treatments in peripheral blood, gills and kidneys erythrocytes, respectively. The frequencies of *separate ENAs* such as micronuclei, enucleus were significantly elevated after Cr↓, Ni↓ treatments in peripheral blood, respectively; apoptotic cells – after MIX treatment in gills and enucleus after Ni↓ treatment in liver compared to control level. Decreased number of *red blood cells*, *haematocrit level*, haemoglobin concentration and increased number of white blood cells in peripheral blood was measured after MIX treatment. However, only decrease in haemoglobin concentration was statistically significant.

Keywords: Genotoxicity; comet assay; cytotoxicity; bioconcentration factor (BCF); *Rutilus rutilus;* metallothioneins

GENO-, CYTOTOXICITY AND TOXICITY INDUCED BY *SAPROLEGNIA PARASITICA* AND CADMIUM ALONE AND IN COMBINATION TO *ONCORHYNCHUS MYKISS*

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Abstract
The aims of present study were to determine genotoxicity, cytotoxicity and toxicity induced by *Saprolegnia parasitica* at concentrations 92000, 22400 and 5500 *colony-forming units per milliliter* (cfu/mL) and Cd (2 µg Cd/L as $CdCl_2 \cdot H_2O$) alone and in combination to rainbow trout *Oncorhynchus mykiss* larvae after 8-day treatment. The formations of micronuclei (MN) and nuclear buds (NB) were assessed as genotoxicity, while 8-shaped nuclei and fragmented-apoptotic (FA) erythroblasts were assessed as cytotoxicity endpoints. Significant induction of MN frequency was detected after treatment with the lowest concentration of *S. parasitica* and after co-exposure. In contrast, significant elevation of NB was measured exceptionally after exposure to the highest *S. parasitica* concentration. Total level of genotoxicity endpoints showed significant elevation after the highest, the lowest *S. parasitica* concentrations and co-exposure treatments. Significant changes in cytotoxicity endpoints were not detected after all treatments performed. Surprisingly, exposure to Cd did not induce any significant changes of selected biomarkers. During the treatment, biological parameters such as heart rate (HR, counts/min) and gill ventilation frequency (GVF, counts/min) were assessed. Toxicity study demonstrated that HR of larvae exposed to *S. parasitica* at concentrations 22400 and 5500 cfu/mL, and 5500 cfu/mL+Cd after 8 days was significantly ($p<0.05$) lower as compared to the control. Additionally, *S. parasitica* at 5500 cfu/mL, and 5500 cfu/mL+Cd induced a significant decrease in GVF in larvae at the end of the test.

Keywords: fish; genotoxicity; cytotoxicity; toxicity; *Saprolegnia parasitica*; cadmium

PHYSIOLOGICAL RESPONSE OF BARLEY AND BARNYARD GRASS TO INTERACTIVE EFFECT OF HEAT WAVE AND DROUGHT

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Abstract

The short-term effect of +10 °C heat wave (HW) treatment both as single stressor (in well-watered plants, HWW) and simultaneously with drought (HWD) was tested in growth chambers under control environment using pot grown plants of barley (*Hordeum vulgare* L., var. 'Aura DS') and weed barnyard grass (*Echinochloa crus-galli* L.) that exhibit C_3 and C_4 pathways, accordingly. During the 3-day long HW period, both plants grown under well-watered soil conditions showed significantly increased transpiration rate (*E*) and decreased water use efficiency (WUE). Significant changes of photosynthetic rate (P_r) were detected only for barley plants. On the last day of HW treatment, P_r in well-watered barley plants decreased by 13.8% ($p < 0.05$), compared to the control (CTR) ones. When the HW was imposed simultaneously with drought, at the end of the treatment, before plants were re-watered, *E* and WUE in barley plants were in totally different manner than under the single stressor of HW – by 76.6% ($p < 0.05$) decreased and by 13.0% ($p < 0.05$) increased, accordingly. By contrast, in barnyard grass, under HWD treatment, *E* and WUE were in the same manner as under HWW treatment – by 18.4% ($p < 0.05$) increased and by 19.5% ($p < 0.05$) decreased, accordingly. P_r in HWD-treated barley plants at the end of the treatment was considerably lower by 73.5% ($p < 0.05$) and did not returned to the CTR one's value after one-day recovery. While, in barnyard grass P_r was only 6.3% ($p < 0.05$) reduced, but it fully returned to the CTR one's value after one-day recovery. Therefore, contrary to barley, physiological indices of C_4 weed barnyard grass responded more positive than negative to HWW treatment and demonstrated considerably higher tolerance to drought under high air temperature conditions.

Keywords: heat wave, drought, barley, barnyard grass, photosynthesis, transpiration, water use efficiency

SOIL CARBON ACCUMULATION IN BARNYARD GRASS UNDER ELEVATED CO_2 AND SHORT-TERM HEAT WAVES AND DROUGHTS CONDITIONS

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Abstract
Climate change will increase the frequency of heat waves and droughts. In order of this, such extreme weather events are predicted to impact the terrestrial carbon balance. The aim of this research is to analyze the effect of heat wave as single stressor (in well-watered plants, HWW) and simultaneously with drought (HWD) to soil carbon accumulation in barnyard grass (*Echinochloa crus - galli* L.) soil. For this purpose, plants were grown in a closed growth chambers under conditions of 21°C/400 ppm and 25°C/800 ppm. 3 days long heat waves (21°C/400 ppm vs. 31°C/400 ppm and 25°C/800 ppm vs. 35°C/800 ppm) were applied – single and in combination with drought (i.e. fully and not watered during the heat wave period). The results showed that under drought conditions both heat waves (21°C/400 ppm vs. 31°C/400 ppm and 25°C/800 ppm vs. 35°C/800 ppm) significantly decreased carbon accumulation in barnyard grass soil. Under fully watered conditions only heat wave of 21°C/400 ppm vs. 31°C/400 ppm significantly decreased carbon accumulation in soil. Also, it was estimated, that the heat wave of 25°C/800 ppm vs. 35°C/800 ppm decreased carbon accumulation in soil less than the heat wave of 21°C/400 ppm vs. 31°C/400 ppm. These findings may indicate that elevated CO_2 could mitigate the effects of heat waves and droughts on soil carbon accumulation.

Keywords: heat wave; drought; carbon; soil; barnyard grass

SHORT-TERM EFFECTS OF ELEVATED AIR TEMPERATURE AND ATMOSPHERIC CO_2 ON BELOW-GROUND CARBON ACCUMULATION IN *HORDEUM VULGARE* AND *PISUM SATIVUM*

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Abstract
Global changes such as elevated atmospheric CO_2 and air temperature are altering the input rates of carbon to plants and soil. In order to study organic carbon ($C_{org.}$) accumulation in the below-ground and to investigate if there is a dependency between photosynthetic rate and below-ground processes of different crop species under increasing levels of air temperature and atmospheric CO_2, a closed growth chamber experiment was performed with spring barley (*Hordeum vulgare* L.) and pea (*Pisum sativum* L.) in a controlled environment at ambient [21 °C/400 ppm] and elevated [25 °C/800 ppm] temperature and CO_2 conditions. The results showed that after 4 weeks of treatment under elevated air temperature and atmospheric CO_2 conditions barley and pea has accumulated organic carbon in roots and soil by different trends. While organic carbon increased ($p>0.05$) in roots and soil of pea, it decreased ($p>0.05$) in roots and soil of barley under conditions of [25 °C/800 ppm], compared to that under conditions of [21 °C/400 ppm]. Contrary, microbial biomass carbon increased in soil of both plant species - microbial biomass carbon increased by 55% ($p<0.05$) in barley soil and by 40% ($p<0.05$) in pea soil under conditions of [25 °C/800 ppm]. Our results also suggested that there was no significant correlation between photosynthetic rate and below-ground processes.

Keywords: below-ground carbon; closed chamber experiment; spring barley; pea

THE USE OF MODERN TECHNOLOGIES IN RECORDING AND MONITORING OF RIPARIAN FORESTRY SPECIES IN GREECE. THE CASE OF CANKER STAIN DISEASE OF PLATANUS ORIENTALIS L.

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Abstract
Modern technologies are a useful tool for recording and monitoring the ecological status of ecosystems. Riparian forests are at risk from intense human activities, pressure and diseases. The *Platanus orientalis* L. is a riparian forestry species that has, for years, withstood human pressure. However, in recent years it is in danger of extinction by *Ceratocystis fimbriata f.sp. platani*. There are records and worrying facts about the spread of the fungus, mainly in western Greece.

Modern technology constitutes a key tool and can be used as an effective way of timely recording and dealing with existing and future interference of the *Platanus* at national level. The system combines innovative basic research into Urban Forestry and urban ecosystems by developing an integrated platform for data collection and decision making to optimally manage and protect the *Platanus* by visualizing and quantifying the problem of the proliferation.

The aim of this paper is to present the electronic database DENDROLOGIO, as well as its first application in the recording of the spread of the post-chromatic ulcer of the *Platanus orientalis* L. in western Greece.

Keywords: Riparian forests, Platanus orientalis L., Dendrologio, Ceratocystis fimbriata f.sp. platani Greece

STABLE ISOTOPE MASS BALANCE TO ASSESS CLIMATE IMPACT IN LAKE SYSTEMS

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Abstract

Isotope mass balance was performed based on 10 eastern Mediterranean stations from International Atomic Energy Agency - World Meteorological Organization (IAEA-WMO) precipitation network. Theoretical lake water isotope values were calculated and compared with measured lake water isotope values from literature data corresponding to different hydrological types of lake systems in the eastern Mediterranean. It is concluded that isotope limnology theory corresponds well to different lake water systems. $\delta^2H/\delta^{18}O$ ratio is a robust index to monitor the response of lake systems to climate variations. We can estimate the $\delta^2H/\delta^{18}O$ ratio for lake systems with different topographical and hydrological characteristics and compare it with the theoretical values that came up for the eastern Mediterranean lakes resulting in conclusions about the intensification or recession of evaporation process. So, the $\delta^2H/\delta^{18}O$ ratio of measured data in lake systems is a quantitative method to estimate climate change impact to lake systems. Isotope mass balance model unshackles us from the narrow grid-cell station density to satisfy the monitoring goal and facilitates the study of lake systems in a larger spatial scale.

Keywords: Isotope mass balance model, lakes, Mediterranean, climate change

INVESTIGATING CONSUMER ATTITUDES TOWARD SUSTAINABLE AGRICULTURAL PRODUCTION AND "ENVIRONMENTALLY FRIENDLY" FOODS: A QUALITATIVE APPROACH

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Abstract

Modern agricultural systems have invested a considerable amount of effort and resources on product development and innovation by supporting sustainable practices and introducing "environmentally friendly" foods in the supply chain. The necessity to find cost effective solutions for addressing important environmental, nutritional and ethical issues has led to the reassessment of how food systems are organized and the identification of strategies aimed at influencing food consumption and promote healthy and sustainable diets. The objectives of this contribution were to determine consumer awareness of sustainability and expectations of sustainable agriculture, and further explore attitudes toward eco-friendly foods. Qualitative data were collected by means of five focus group discussions conducted with adults residing in the regional area of Evros, in Northern Greece in order to get insights into consumer perceptions of sustainability, and motivations factors to purchase and consumption of "environmentally friendly" foods. Our findings showed that consumers are proponent of sustainable agricultural practices, and attach importance to environmental protection, rural development, food safety, naturalness and social equality. Most participants perceive that sustainable foods are more healthy and nutrient than their conventional equivalents, but also seem to identify sustainable production with organics. The great majority of consumers showed a strong preference to organic foods, although they noted a high price difference between organic and conventional products. However, a few consumers reported a regular consumption of organics, explaining that they have confidence in the control and certification processes, although added costs or difficulties in the availability of organic products may constitute an important barrier to their consumption. Action plans should be considered to increase awareness of sustainable diets and achieve greater confidence in the label and certification processes in order to increase the general demand of eco-friendly products and improve environmental quality and sustainability.

Keywords: focus groups, sustainability, eco-friendly foods, consumer attitudes, organics



Soft and renewable energy sources

A NUMERICAL TOOL FOR THE TIME-DOMAIN ANALYSIS OF FLOATING WAVE ENERGY CONVERTERS

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Abstract

In the present paper, a computational tool (FloaTWEC tool) is developed for the time-domain analysis of a floating oscillating-body Wave Energy Converter (WEC). Assuming a floating body with six rigid-body modes, the WEC's response is calculated based on the well-known Cummins equation, where fluid memory effects are captured through appropriate convolution terms. The required frequency-dependent excitation loads and hydrodynamic coefficients, as well as the hydrostatic-gravitational coefficients are obtained using a standard hydrodynamics (waves-floating structure interaction) software. The Power-Take-Off (PTO) mechanism can be modeled as a linear or non-linear system, while mooring lines can be considered as additional stiffness forces. The equation of motion is solved using the Newmark implicit time integration scheme, whereas the analysis can be implemented under the action of regular and irregular waves, assuming motion in all or appropriately selected rigid-body modes. FloaTWEC is, initially, validated through comparison of results with numerical and experimental results of other investigators for three different floating structures. Then, it is applied for the case of a heaving WEC with a linear PTO for: (a) assessing its response and its power absorption under the action of regular and irregular waves of different characteristics and (b) investigating the effect of the stiffness of the mooring lines on its performance.

Keywords: wave energy; wave energy converters; time-domain analysis; Cummins equation; absorbed power

OPTIMAL OPERATION SCHEDULING OF MULTIPURPOSE PUMPED STORAGE HYDROPOWER PLANT WITH HIGH PENETRATION OF RENEWABLE ENERGY SOURCES

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Abstract

The high penetration of renewable energy sources, such as solar and wind, into the electricity system requires large-scale, flexible storage and production systems for uninterrupted power supply, to reduce as much as possible the amount of energy discarded. The pumped-storage method through coupled reservoirs has been globally recognized as a mature, competitive and reliable technology for the storage of large quantities of electricity and is suitable for our country, due to its particular geomorphology. Its application may increase the degree of exploitation of hydroelectric projects, without decrease of the availability of water resources. Optimization of renewable energy sources penetration through reversible reservoir systems is a very complex, multi-parameter, non-linear problem, as the reservoirs, besides hydroelectric power generation, serve many other objectives such as water supply, irrigation and flood protection, while their function should observe constraints such as environmental flow.

This paper examines the possibility of optimizing the penetration of wind energy into a pumped-storage multi-reservoir system. The process of simulating and optimizing the system has been implemented through the development of a program in the Microsoft Visual Studio 2015, based on the genetic algorithm (GA) method. Genetic algorithms are a widely used non-linear optimization method that has been successfully implemented to problems of management of large scale complex water and energy systems. The results show that when the operation of the reservoir system is coordinated with the wind farm, the hydroelectricity generation decreases, but the total economical revenue of the system increases by about 7.2% and can achieve high wind energy penetration to the electricity grid.

Keywords: Pumped-storage plant, multi-reservoir systems, renewable energy, optimization, genetic algorithms

EVALUATION OF CYPRUS ENERGY RESOURCES IN THE FRAMEWORK OF ENVIRONMENTAL SUSTAINABILITY USING A NOVEL SWOT-PESTEL APPROACH

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Abstract
According to several EU Directives, Cyprus qualifies and is classified as an Emerging Market for Natural Gas and also as Isolated Energy Market. The Country energy natural resources face several contradictions. On one hand, there is not any specific strategy in political level regarding when and how indigenous fossil reserves will be extracted although their commercial exploitation could offer to the Island energy security. Moreover, there are not any oil or gas pipelines as well as no electricity interconnections with other countries. On the other hand, several Sustainability (mainly environmental) targets set by United Nations and the European Commission (either as policies, regulations or directives) must be adopted and therefore fossil fuel use should not be promoted and the contribution of Renewable Energy Sources (RES) must be increased. So, Cyprus needs rather than any other country in the area a holistic sustainable strategy regarding the promotion of RES and to manage its own fossil hydrocarbons reserves. For this a detailed energy resources sustainability strategy analysis is required in order to be able to evaluate the available inputs and to formulate sustainable energy strategic planning. This paper proposes a novel approach to combine PESTEL and SWOT analysis in order to assess the ability to use PESTEL environmental context analysis to categorize and evaluate not only the pillar of externalities, but also the energy resources sustainability internalities. The method is implemented for Cyprus energy resources and emerges not only a number of sustainability opportunities and threats, but also strengths and weakness for the island's future energy resources sustainable development strategy. Furthermore, it is obtained that the proposed novel approach, as it is able to acquire useful results, is promised and suitable for environmental analysis which is a crucial part of the strategic management planning process.

Keywords: PESTEL; SWOT; natural resources; sustainability; energy strategic planning

BIOCLIMATIC HOUSE DESIGN BY APPLYING PASSIVE SYSTEMS AND GREEN ROOF

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Abstract
A major issue that contemporary society deals with is adopting "sustainability" and "viability" values. The solution to this problem comes through a complex process. In that process the building sector is a vital factor and should not be eliminated. In this paper, it is presented the design and the construction of a house that obeys to the principles of bioclimatic design. In this bioclimatic residence, it is applied passive systems over its building shell. Moreover, one more characteristic which worth to be mentioned is the use of green roof because of the benefits that derives through it. The aim of this paper is the design of a building that exploits natural resources, reduces carbon dioxide emissions and provides thermal comfort to its users. Finally, it is displayed a comparison of the economic and energy benefits between a bioclimatic home and a conventional one.

Keywords: bioclimatic design, green roof, passive systems, energy benefits, natural resources

OPTIMIZATION OF SITE SELECTION OF AN ANAEROBIC DIGESTION PLANT FOR TREATMENT AND VALORIZATION OF LIVESTOCK LIQUID MANURE WITH THE AID OF GIS

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Abstract

Mygdonia Basin is located mostly in north and northeast part of Thessaloniki Regional Department and in a small part of north Halkidiki Regional Department, including two lakes, Koronia and Volvi, the forest of the Macedonian Tembi Valley and many streams forming a dense water network. The whole area of 2,090 km^2 is protected by two Joint Ministerial Decisions, which define all land uses and economic activities that are allowed to be developed in each of its three zones of protection. The area of study involves a "Natura 2000" site – "Special Protected Areas" – as well. The area is characterized for its intense agricultural activities, as well as livestock plants and activities, which demand a great amount of irrigation water; a great number of the 80,722 inhabitants in 80 small towns live from such economic activities. However, most of the livestock farms operate without effective animal wastes management methods, while such wastes involve high organic load.

The present paper investigates the possibility for optimization of site selection of an anaerobic digestion plant for liquid manure treatment in the area of Mygdonia Basin, with the aid of Geographical Information System (GIS). For this reason, legal, social, ecological and economic criteria are set, identified and briefly described. They are related to: the restrictions in land uses and activities permitted by the two joint ministerial decisions for Mygdonia Basin (legal criteria); a minimum necessary distance of the proposed anaerobic digestion plant from current towns (social criteria); the ecological characteristics of the area of study with the "Special Protection Area" and the local wildlife refuges (ecological criteria); and the need for location of the proposed anaerobic digestion plant mostly next to the largest livestock farms (economic criteria). With the appropriate spatial data and spatial analysis within the GIS, the synthesis of all criteria that have been set, is completed successfully and the site for the anaerobic digestion plant location is chosen. The present paper set and selected simple criteria, while the problem of site selection for the anaerobic digestion plant is more complex; however, it is a pilot work showing that there are possibilities to solve problems in this area that has been polluted for more than two decades. Furthermore, a critical comment is made related to the implications of Environmental Impact Assessment Study for such a project, which is strongly affected by land use patterns proposed by General Local Plans.

Keywords: Livestock liquid manure, Anaerobic digestion, Spatial analysis with GIS, Mygdonia Basin

DESIGN OF A GROUND SOURCE HEAT PUMP SYSTEM FOR A SCHOOL AND A HOTEL OPERATING IN DIFFERENT SEASONS

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Abstract

In this paper, we study the design of a ground source heat pump system (GSHP), which serves both a school and an adjacent hotel, to improve the financial performance of the project and minimize the impact on the ground source temperature. For the purposes of this study we assume that the GSHP provides part of the required heating during the school's operating months and part of the required cooling for a five- month- operating period for the hotel.

The paper introduces a simple way to estimate the length of the ground heat exchanger (GHE), minimizing the total cost of the project. The total cost includes the initial cost composed of drilling, excavation, heat pumps and piping network. The operational cost is included to account for the energy consumed for the heating and cooling of the buildings. The peak load for each building is calculated with the commercial software 4M and the monthly & yearly annual load are calculated with both the national calculation tool for building energy performance - TEE KENAK and RETScreen 4. For the calculation of the total length of the GHE, the method proposed by ASHRAE and modified by Philippe is used. We test multiple scenarios for different thermal load inputs, corresponding to different percentages of the heating and cooling demand. The economic viability of the project is determined by calculating the Net Present Value of each of the respective scenarios.

Keywords: Geothermal heat exchanger, Ground Source Heat Pump, RETScreen, Cost optimization

FEASIBILITY STUDY OF A FLOATING OFFSHORE WIND FARM IN GREECE

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Abstract

Offshore wind energy presents an abundant renewable energy source that can contribute to the satisfaction of the European Union's energy policy targets. Although nowadays large-scale Offshore Wind Farms (OWFs) have been commercially deployed in shallow waters areas, the existence of stronger and more consistent wind fields in offshore areas of deeper waters has triggered the development of floating Offshore Wind Turbines (OWTs) of large capacity and has very recently lead to the installation of the first pilot floating OWF. Greece is a Mediterranean country with a vast wind energy potential at specific marine areas characterized by deep-water conditions. Thus, the potential of deploying floating OWFs should be considered and examined.

Motivated by this, the aim of the present paper is to determine the economic feasibility of a floating OWF in Greece. The proposed OWF is considered to be deployed at a marine location in the north-central Aegean (east of Mykonos island), which satisfies specific sitting criteria, and it is designed to cover the annual energy demands of Mykonos, Delos and Rhenia islands. For the development of the proposed investment, two alternative scenarios are examined, by modifying the number and the rated power of the OWTs, as well as the distances between them. The 1st scenario corresponds to an OWF with 11 floating OWTs (spar buoy floating platform) of 33 MW total rated power, while the 2nd one to an OWF with 7 floating OWTs (spar buoy floating platform) of 35 MW total rated power. The net annual energy production of the two alternative scenarios is estimated considering wake losses, electrical losses and OWTs' availability. Wake effects are estimated using Jensen's model. The selection of the best scenario is based on the comparison of the Levelized Cost of Energy (LCOE) of the two alternatives. The finally selected scenario (1st scenario) is evaluated using the net present value method, the internal rate of return and the payback period of the investment.

The results indicate that the most important parameter affecting LCOE and, therefore, determining the final investment decision between the two proposed alternative scenarios, is the OWF's capacity factor. Moreover, the results of the economic analysis/evaluation of the finally selected scenario clearly illustrate the economic sustainability of the proposed OWF and, therefore, its potential for covering effectively the annual energy demands of the examined islands.

Keywords: Floating offshore wind farm, Levelized cost of energy, Investment evaluation, Net present value, Internal rate of return

FLOATING PHOTOVOLTAIC POWER GENERATION SYSTEM DEVELOPMENT IN A LAKE

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Abstract

Solar energy is practically an inexhaustible, clean source of energy. In order to produce multi-MW electricity from solar energy, large capacity facilities are required, that occupy wide installation areas. Therefore, an important prerequisite at an early stage of the realization of a multi-MW solar energy project is the availability of suitable, large-size, surface areas. In countries, such as Greece, which have quite limited land area, with a significant proportion allocated for agriculture, protected forests and for other land uses, the deployment of floating photovoltaic systems in closed water bodies to harness solar energy presents a potential, attractive, alternative solution.

Motivated by this, the aim of the present paper is to propose, develop and investigate the feasibility of a Floating Photovoltaic power generation System (FPVS) in a lake in Greece. For this purpose, the Polyfytos artificial lake in North Greece is selected, considering environmental/legal restrictions and the available lake's surface size. This selection is further supported by the satisfaction of other site-selection criteria related to economical/technical parameters. The exact installation location of the FPVS in the lake is defined considering, mainly, minimization of visual impacts and shading effects from the surrounding mountains, as well as easy accessibility facilitating maintenance actions. A FPVS of 2 MW power capacity is proposed, so that the electricity demands of the neighboring villages can be met. This FPVS is preliminary designed by defining its geometrical and technical characteristics. For increasing the power production of the proposed FPVS, smart technologies are integrated within its design (i.e. use of tracking system), exploiting the advantage of the FPVS's deployment in a water body. Finally, the economic performance of the proposed FPV power generation system in terms of levelized cost of energy is estimated by calculating and assessing construction, operation and maintenance costs.

The results of the present paper illustrate that the proposed FPVS deployed in the Polyfytos Lake in Greece has the potential to present a viable economic solution for covering effectively the energy demands of the neighboring areas. Moreover, the development of a FPVS over a water reservoir has a significant positive effect (increase) on the electricity production effectiveness compared to a land-based PV power generation system, since in the case of a FPVS smart technologies can be more efficiently applied.

Keywords: Floating photovoltaic power generation system, Greece, Lake, Financial analysis, Levelized cost of energy

MAXIMIZING THE BUILDING ENERGY PERFORMANCE WITH ADVANCED VENTILATED FAÇADE SYSTEMS ON EXISTING STRUCTURES

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Abstract

Within the existing European building stock, a large share is built before 1960, when there were only a few or no requirements for energy efficiency. Given that only a small portion of these buildings have undergone major energy retrofits, it is easily concluded that the oldest part of the building stock contributes greatly to the high energy consumption of the building sector. The most common action for the energy retrofit of the building envelope is the external insulation of the existing walls. Recently, ventilated façade systems were developed to offer thermal insulation together with the protection of buildings against the combined action of rain and wind, offering at the same time high level aesthetic characteristics. However, even if an advanced technological solution is used, such as the ventilated façade one, the poor air quality problems of older buildings are not always addressed, as through the interventions the buildings are made more airtight, and consequently less naturally ventilated. The research project E2VENT, funded within the H2020 program, attempts to address these problems met in existing residential buildings. It concerns merely a cost effective, high energy efficient, low C02 emission, replicable, low intrusive, systemic approach for retrofitting of residential buildings, through the integration of an advanced ventilated façade system, a heat exchanger and a heat storage system.

In this paper the technological solution that is developed within the framework of the research project is described, the possible barriers of its market acceptance are given, and results on its expected performance when installed in typical existing buildings are presented. Emphasis is given on the parameters that are associated with the thermal performance of the E2VENT system, as its main target is to reduce the building energy substantially, supporting the framework of the nZEB concept.

Keywords: Ventilated facade; building energy performance; energy retrofit; existing buildings; thermal insulation

APPROPRIATE WIND FARM SITTING: THE CASE STUDY OF REGIONAL UNIT OF MAGNESIA

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Abstract

Wind energy is one of the most important renewable energy sources, especially in regions where appropriate wind power potential exists, hence, decisions on harvesting such a resource plays an instrumental role in determining the appropriate policies required to achieve energy and climate targets. The appropriate siting of such facilities has become of great concern the last decade and is revealed by the significant growth in onshore wind farm siting applications across different application areas worldwide. Wind velocity, slope, distance from specific areas (protected areas, forests, urban areas, archeological sites) as well as from specific infrastructures (airports, road network, electricity grid) are amongst the prevailing criteria used in defining sustainable sites for wind farm development. The main aim of this paper is to identify appropriate sites for onshore wind farm applications considering the restrictions imposed by the legislative framework of the Special Framework for Spatial Planning and Sustainable Development for renewable energy sources (SFSPSD-RES) (Greek institutional framework for wind farm siting) with the use of Geographical Information Systems (GIS). The application focuses on the Regional Unit of Magnesia. The methodology involves excluding areas and zones defined by the SFSPSD-RES as well as outstanding criteria applied in the international literature review. The results reveal that the appropriate sites for wind farm siting are rather handful mainly due to the low wind potential of the area.

Keywords: Renewable Energy Sources (RES); wind energy; wind farm siting, exclusion criteria

HARNESSING THE BLUE RENEWABLE ENERGY SOURCES OF THE COASTAL CEPHALONIA'S PARADOX AND THE EURIPUS STRAIT

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Abstract
The sea represents a huge potential for Blue Renewable Energy Sources (BRES) such as waves, tides and marine currents, including the Euripus Straits and the Cephalonia's Coastal Paradox. The possibility of exploiting the BRES, of zero-head sea and tidal currents, for power generation has given little attention in Europe, in Mediterranean countries and in Greece, despite the fact that such currents, representing a large renewable potential, could be exploited by modern technologies to provide important levels of electric power. The present paper tries to describe simple physical models for the hydraulic explanations of two of the most astonishing marine currents of the world, the Cephalonia's Coastal Paradox (CCP) and the Euripus Strait Current (ESC), continuing to puzzle the scientists for many decades. The CCP is consisting of a mysterious flow of the "through the island" strong underground coastal current, with a continuous seawater inflow in the Livadi Gulf, near Argostoli, reappearing in the other side of the island, in the Gulf of Sami. Passing from the Ionian Sea to the Aegean Sea, the CCP finds its hydraulic flow analogue, in the tidal current of ESC, also among the most famous world coastal phenomena. This is a remarkable exceptional fact in spite that tidal currents in the Mediterranean Sea are in general comparatively weak. Since ancient times many scientists try to cite advanced arguments towards parts of the global "Euripus problem" solution. One of the main aims of the present paper is to propose innovative efficient technical solutions, in order to harness the current potential of the CCP and the ESC, with a series of innovative Horizontal Archimedean Screw Turbines, based on the first in the world Horizontal Archimedean Screw Turbine built and studied at BOKU Vienna University.

Keywords: blue renewable energy sources, coastal Cephalonia's paradox, Euripus strait current, kinetic small hydro plants, Archimedean screw turbines

A PANHELLENIC SURVEY (2017-2018) REGARDING ENERGY NEEDS COMFORT CONDITIONS AND ATTITUDES TOWARDS RENEWABLE ENERGY SOURCES

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Abstract

There is no official estimation regarding the Energy Poverty in Hellas during the recent years. Several studies have been carried out independently, regarding specific areas or social groups, but none has covered the whole of the population.

The main aims of this research study, presented here are how peoples' attitudes and views towards the Energy subjects and the use of Renewable Energy Sources (RES) are affected by the Economic Crisis, and a rather dystopian general future. How serious and important are the environmental issues considered to be when people feel that their everyday life is threatened? This subject is approached through this Panhellenic survey analyzing the data gathered by questionnaires.

A large number of areas and cities have been covered, offering a satisfactory image of the subject.

Conclusions of this research project regard:

a) the comfort conditions in the houses of the participants, and how these conditions have been changed lately. Due to the economic crisis.
b) The attitudes of the people towards Renewable Energy Sources (photovoltaics, wind turbines, etc), the energy saving policy and related devices and how these attitudes have been affected by the economic crisis, the tariff policy and the bureaucracy.
c) The attitudes of the participants towards energy and environmental subjects in our country, and how these attitudes have been affected by the current situations.
The conclusions of the research project are hopefully very important describing the people’s attitudes towards energy needs, fuel consumption and R.E.S. matters during this critical period of the country.

Keywords: Energy needs; social survey; Energy poverty, RES; Economic crisis.

A TWO STEP PROCESS FOR THE ELECTROCHEMICAL CONVERSION OF CO_2 TO METHANOL

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Abstract

The direct electrochemical conversion of CO_2 to methanol, which is the product of choice, is quite difficult. On the contrary, formic acid is easily formed from CO_2 on various metal electrodes by both high rate and %Current Efficiency (%CE) reaching 90%. This work proposes a two-step process for the electrochemical conversion of formic acid to methanol which includes the conversion of CO_2 to formic acid in the first and the reduction of formic acid to CH_3OH in the second. The work contains experimental results on the reduction of formic acid on chromium and chromium alloys. The main products obtained from the electrochemical reduction of HCOOH on Cr in 85% H_3PO_4, at 80 °C were $HCOOCH_3$ (2.1%), CH_3OH (17.5%) and CH_4 (4.9%). The rate of the reduction increased with the negative potential. The total %CE in some experiments exceeded 100% and this was attributed to the cathodic dissolution of chromium which provided an additional reduction capacity. The reduction on electrodeposited chromium on Pb gave CH_4 (25.7%) and less amounts of CH_3OH and $HCOOCH_3$. On stainless steel cathodes the main products were CH_3OH (%7.2) and $HCOOCH_3$ (23.1%) and smaller amounts of CH_4.

Keywords: Formic acid; electrochemical reduction; chromium

EFFECT OF SUCCESSIVE SMALL HYDROPOWER PLANTS ON WATER QUALITY

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Abstract

The aim of this work was to evaluate the influence of two successive small hydropower plants (SHPs) on the water quality of the Vokė river (Lithuania). Two SHPs (‘Vokė’ and ‘Grigiškės’) is situated in the 7 km long section of the river, close to Vilnius, the capital and the biggest Lithuanian city. Water samples were taken in the dams above SHPs, in the rapids immediately below SHPs and 2 km below each SHP. The concentrations of nitrates (NO_3^--N), nitrites (NO_2^--N), ammonium (NH_4^+-N) and phosphates (PO_4^{3+}-P), and chemical oxygen demand (COD) were investigated. An increase in N and P compounds was detected in the dams above both SHPs. The highest increases were characteristic for phosphates (~40%, $p < 0.05$) and nitrates (34% and 41%, $p < 0.05$, in the ‘Vokė’ and ‘Grigiškės’ dams, respectively). Strong and statistical significant increase in the level of ammonium was observed only in the ‘Grigiškės’ dam (31%). Contrary to NO_3^--N, NH_4^+-N and PO_4^{3+}-P, concentration of NO_2^--N were lower in the dams of both SHPs. Strong and significant increase in BOD7 (33%, $p < 0.05$) was detected only in dam of ‘Vokė’ SHP. Considering the river sections 2 km below SHPs, water quality changed negligibly. The levels of biogenic N and P compounds tended to decrease; however, sharp increase in PO_4^{3+}-P concentration was detected below ‘Vokė’ SHP, indicating an impact of subsequent ‘Grigiškės’ SHP. The levels of nitrates and phosphates were higher in the downstream ‘Grigiškės’ SHP, as compared to ‘Vokė’ SHP, both in the dams and in the subsequent rapids. The results of this study have shown that the levels of biogenic and/or organic compounds tend to increase in the dams above SHP. The concentrations of phosphates and nitrates further increase downstream due to the successive SHPs.

Keywords: Small hydropower plants, water quality, biogenic compounds, chemical oxygen demand

DEVELOPMENT OF A GIS-ASSISTED MULTI-CRITERIA APPROACH FOR THE PROPER LOCATION OF WIND FARMS IN FLORINA REGION

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Abstract
Socio-economic and technological development are strongly connected to energy supplies. Recent advances in different sectors contribute to a huge increase for energy demand. This aspect combined with the issues of climate change and sustainable development lead to the necessity of using Renewable Energy Sources (RES). Wind energy is one of the most promising forms of RES in Greece, resulting in increasing global wind farm installations. Although wind energy is environmental friendly and renewable, it is still necessary to form specific criteria for the proper spatial planning of wind farms. In Greece, such criteria are described in detail in the Special Framework of Spatial Planning and Sustainable Development for Renewable Energy (SPSDRE). The purpose of this research work is the evaluation of wind potential in the Regional Prefecture of Florina (northern Greece) and the implementation of a multi-criteria GIS-based analysis for the determination of suitable locations for a wind farm operation. The application was performed in Florina region, after taking into consideration the available geospatial data and the guidelines of SPSDRE. Results concerning the location suitability are based on the AHP method (for the criteria' weights determination) and the Weighted Linear Combination (WLC), defining the locations with the highest final score.

Key-words: wind, RES, Florina, GIS, multi-criteria analysis

EXPERTS' EDUCATIONAL PROFILE FOR CONCENTRATING SOLAR THERMAL SYSTEMS IN GREECE

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Abstract

The technology of Concentrating Solar Thermal (CST) systems is expected to play an important role in future energy scenarios at national, European and global level, due to the CST systems capacity to operate as base load power stations and its ability to store and future-use thermal energy.

CST systems are complex physical and chemical processes installations of high power, with increased operational and control requirements. Their operator, which according to the used terminology is called "Solar Field Operator" (SFO), should therefore be a professional who has the necessary skills to perform certain tasks, in order to operate efficiently and safely the CST plant. In the framework of the European project "*SOLAR CV - SSA to cover skills needs delivery and recognition of EU joint CV in Concentrated Solar Pow*er" the necessary skills in national and European level were investigated, so as to identify the need for training of the future SFOs. The procedure followed in *SOLAR CV* was focused on the identification of the profile of SFO working on Parabolic Trough (PT) plants, since this is the most mature and commercial technology of the CST systems.

The identification of the SFO skills and training needs for Greece was carried out by following the next steps; firstly, a network of experts on CST and Vocational Education Training (VET) was established; then CRES conducted a research on CST skills needs for SFO in Greece and - in close collaboration with the rest of *SOLAR CV* project consortium and the experts of the labour market network – created a list of required skills for SFO working in a PT plant; finally the identified skills were evaluated and verified by a small specialized group of experts – from universities, research centres, the solar industry - in the CST sector in Greece, through a questionnaire-based survey.

The outcome of the methodology applied, resulted in a series of main and secondary tasks of the SFOs. The main tasks are related to the operation of the field control room, troubleshooting, planning of maintenance work and actions to improve the operation of the PT plant. Secondary tasks related to standardization, handling of manuals, protocols and technical guides related to the CST fields were also examined.

In this research work the methodology for the identification of SFOs' needed skills, the list of identified required skills and the level of importance of the identified skills for SFOs in Greece - as it was suggested by the Greek CST and VET experts - are presented.

Keywords: Concentrating Solar Thermal systems, Parabolic Trough systems, training, solar-field operator.

SOLAR THERMAL MARKET AND PENETRATION FACTORS' ANALYSIS IN EUROPE

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Abstract
This study presents the Solar Thermal (ST) market of low and medium temperatures nowadays in Europe, analyses the European market for the decade 2005 to 2015 and elaborates the respective penetration factors for countries' ST market development. This research focuses on the technologies of water unglazed and glazed Flat-Plate Collectors (FPC), Evacuated Tube Collectors (ETC) and air collectors, since these are the dominating ST types in Europe.

The survey was based mainly on the International Energy Agency (IEA) reports "*Solar Heating and Cooling Programme - Solar heat worldwide: Markets and contribution to the energy supply*" (years 2011 to 2017) and "*Technology Roadmap: Solar Thermal Electricity 2014 edition*", on the European Solar Thermal Industry Federation (ESTIF) reports "*Solar thermal markets in Europe - Trends and market statistics*" (years 2005 to 2014), and on the EurObserv'ER reports "*The state of renewable energies in Europe*" and "*Solar thermal and concentrated solar power barometers*". Other official organizations' reports from European Copper Institute and CRES, as well as relevant scientific publications, were also taken into account.

Data collected were elaborated to analyse the ST market development for the decade 2005 to 2015 for the top 15 European Union (EU) countries, with the highest ST market penetration in 2015. Population data from the International Data Base of the United States Census Bureau were used to calculate the ST market development per capita for the decade 2005- 2015. The main factors that influence the ST market development were examined and discussed.

The analysis of the present study has shown that the ST technologies of low and medium temperatures in Europe are well-established and with great perspectives for the future. The ST market development analysis for the decade 2005 to 2015 has revealed interesting remarks; For example in 2015, Germany has the 1st position in terms of total installed capacity, but it has the 4th position in terms of installed capacity per capita. In the contrary, Cyprus has the 10th position in terms of total capacity, but it has the 2nd position in terms of total installed capacity per capita. Greece is ranged at the 3rd position in both terms - total capacity and total capacity per capita, revealing its well-established ST market.

The main factors that influence the ST market development – positively or negatively – are related to the economic situation of the country, the favourable or deterrent legislative framework, the status of the construction sector, the national incentives and financial support programs, the prices of mineral resources and electricity per period and the promotion or not of competitive RES in the country.

Keywords: solar thermal systems; solar energy; solar thermal market analysis; solar thermal technologies, solar market penetration factors



River and open channel hydraulics

DISCHARGE AND SEDIMENT TRANSPORT IN THE NESTOS RIVER BASIN, DOWNSTREAM OF THE DAM OF PLATANOVRISI

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Abstract
The prediction of the runoff and sediment yield in the basin of the Nestos River, located in Macedonia and Thrace, Northern Greece, is the subject of the present study. The AGNPS software was employed, in order to assess the basin's behavior downstream of the hydroelectric dam of Platanovrisi, which is located approximately at the middle of the river's course inside the Greek territory. The technique used in order to model the impact of the dam, was to modify the study area's digital elevation model and represent the discharge of the dam as a point source of water. Two different simulations were conducted, one for the years 1980-1990 and another for the period 2006-2030. The simulation for the years 1980-1990 was conducted using recorded meteorological data, whereas the simulation for the period 2006-2030 was based on rainfall and climate data generated by two software packages, namely GlimClim and ClimGen.

Keywords: River basin, Discharge, Sediment transport, Dam

URBAN STREAMS OF THESSALONIKI (GREECE): SPATIAL AND HYDRAULIC ASPECTS

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Abstract

Rapid and poorly planned urban development has resulted in severe deterioration of the environment, in many parts of the world, including Greece. Amongst the environmental elements that have been heavily affected are local streams of small and medium size. Degradation resulted mainly from flaws of the respective legal framework and from trespassing, which was tolerated, more or less, by the pertinent authorities. In other cases, streams were reduced to closed conduits, according to development plans that disregarded environmental components. This behavior towards urban streams had many adverse effects. The most severe is aggravation of flood phenomena, which are further intensified by turning permeable soil into an impermeable surface during the urbanization process.

Today, in contrast to these practices, an attempt is being made to promote streams as key factors in the achievement of sustainable urban development through a more integrated management. Following this approach, we study the possibility of managing the streams that are preserved, at least partly, within the administrative boundaries of the Municipality of Thessaloniki, Greece. Thessaloniki is a very densely built area, within which several streams or stream parts are "hidden". In particular, we analyze and evaluate the spatial and hydraulic characteristics of these streams, together with the pressures they have received from human activities. We round off, this paper, by presenting certain proposals concerning the nexus of streams in the Municipality of Thessaloniki, Greece.

Keywords: urban streams, environmental impact, drainage system, Thessaloniki, Greece

ON THE USE OF THE INTEGRAL MOMENTUM-BALANCE TO CALCULATE DRAG ON A SQUARE CYLINDER IN A COMPOUND-CHANNEL FLOW

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Abstract

River flooding, threatens nearby infrastructure, as overbank flow occupies the adjacent berms (floodplains) and poses significant drag loads on the existing structures. The drag coefficient of such structures is possible to be influenced by the strong shear-layer formed at the interface of the main channel and the floodplain. Herein, this assumption is investigated in an experimental configuration involving the placement of an emergent cylinder at the main-channel/floodplain interface. The drag force on the cylinder at a certain distance from the floodplain bed is assessed through the application of the momentum-balance equation, in its integral form. The method is based on local measurements of the mean flow and turbulence characteristics. Drag is expressed as counteraction to the force on the flow in a control volume and is estimated as the residual in the momentum-balance equation.

The experiment was conducted in the straight compound-channel facility of Laboratório Nacional de Engenharia Civil (LNEC), Lisbon. Uniform-flow conditions were set in the channel for a relative flow-depth $h_r=h_{fp}/h_{mc}=0.31$ (h_{fp} is the floodplain flow-depth and h_{mc} is the main-channel flow-depth). A square cylinder was placed in one of the floodplains right next to the main-channel/floodplain interface. An Acoustic Doppler Velocimeter (ADV) was used for measuring the three-component instantaneous velocities at sequential positions on the surfaces of a fluid control-volume.

The terms of the momentum-balance equation were estimated. Then the drag coefficient emerged from the respective drag force and the characteristic velocity U_0 that accounts for the existence of the compound-channel-flow shear layer. The same calculations were applied to the case in which a cylinder is found in flow with uniform upstream velocities. This reference case is represented by placement of the cylinder in the middle of the floodplain in the same facility. The effect of the shear flow is assessed through comparison of the corresponding terms of the momentum-balance equation and the drag coefficients.

Keywords: Drag, Momentum balance, Square cylinder, Compound channel, Velocity measurements

A FUZZY MULTICRITERIA DECISION APPROACH TO SELECT THE OPTIMAL TYPE OF SPILLWAY AT A SPECIFIC DAM

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Abstract

The selection of the optimal type of a spillway is considered as one of the most important parameters for the dam construction. The objective of this research is to develop a multi-criteria decision making model (MCDM) based on fuzzy set theory. For this purpose 5 alternative types of spillways were selected with nine criteria. Since most information available in this stage is not numerical and uncertain, fuzzy set theory and linguistic variables, parameterized by triangular fuzzy numbers (TFN), are used to represent the evaluation ratings of candidate items. The developed model, which is a combination of both methods TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and AHP (Analytic Hierarchy Process), ranks candidate items and assists decision makers in selecting the most proper type of spillway. An example of selecting the optimal spillway is used to illustrate the concept developed.

Keywords: Optimal spillway, Linguistic variables, MCDM, TFN, Fuzzy, TOPSIS method, AHP

MODELLING ENVIRONMENTAL FLOWS WITH LAGRANGIAN PARTICLE MESH-FREE METHODS

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Abstract

Particle methods are computational techniques in which material particles move under the action of forces obtained from the discretization of the governing partial differential equation (e.g. the Navier-Stokes equations in fluids). A large group of recently proposed particle methods are meshless, i.e they do not require an associated mesh or grid in order to track the motion of the particles. As such, particle methods are very well suited for modelling and simulating flows with interfaces undergoing large deformations. In this paper we present a brief review of particle methods with emphasis on the method of Smoothed Particle Hydrodynamics (SPH). Basic concepts of the SPH method such as the integral interpolation method, the discretization of partial differential equations (PDEs) based on distributed nodal points (particles), and the choice of interpolation kernel functions are reviewed. We describe recent work on corrections applied to the original SPH method, the implementation of the method in LAMMPS and on validation of computer codes based on test cases.

Keywords: Particle Methods, Smoothed Particle Hydrodynamics (SPH), LAMMPS, Environmental flows



Environmental law and economics

SPATIAL MULTI-CRITERIA DECISION MAKING MODEL FOR SUSTAINABLE COASTAL LAND-USE AND DEVELOPMENT. THE CASE STUDY OF KALAMARIA-PILEA SEAFRONT IN THESSALONIKI, GREECE.

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Abstract

In the last decade, applications of the Multi-Criteria Decision Making (MCDM) techniques in GIS-based land suitability procedures have been increased, especially at a regional-scale planning processes. Through these procedures, conflicts between urban growth and ecological conservation have been brought to the forefront, especially in developing coastal areas, while potential ecological environmental risks have been emerged as a result of land-use changes (e.g. urbanization). An optimized land-use planning and development could reduce this risk at a regional scale. Modern planning theories encourage approaches with Multi-Criteria Decision Making (MCDM) techniques, combined with GIS, as they have been applied successfully in a number of land suitability analysis and environmental planning and management scenarios.

This study aims to present a realistic and detailed set of criteria and a group decision making, by using MCDM techniques and Analytical Hierarchy Procedure (AHP - Fuzzy AHP), in order to define the most preferred option to secure a sustainable coastal land-use and development at the Pilea-Kalamaria seafront in Thessaloniki, Greece, where no land-use is configured in its largest part. In order to built the MCDM model, the study was organized into four principal stages: (i) defining the land suitability criteria of the model, (ii) ranking the importance of each criterion, (iii) generating land suitability maps for each criterion, and (iv) generating a final map with the suitable land-uses of the study area accompanied by a detailed analysis of the results of the MCDM model and a comparison of the results with the most recently approved General Urban Plan of the study area.

Keywords: MCDM model; land-use planning; coastal area; urban development; spatial optimization

APPLYING THE CONTINGENT VALUATION METHOD TO ESTIMATE THE ECONOMIC VALUE OF THE THESSALONIKI SUBURBAN SEICH-SOU FOREST AMENITIES

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Abstract

Environmental economic valuation of natural public goods and resources is focused on how to place a monetary value on goods and bads, arising from changes that take place within the natural environment and affect environmental quality or the available stocks of some natural resources. The economic techniques available for economic valuation can be divided into three groups: conventional market approaches; constructed market approaches; and implicit market approaches. In constructed market, the most widely approach used is the contingent valuation method (CVM), which uses a direct approach – some form of questionnaire – in order to ask people what they are willing to pay (WTP) for an environmental benefit or willing to accept (WTA) in compensation for a loss. The popularity of the method may be attributed mainly to two factors: firstly, it does not require any great amount of data that is usually necessary for other techniques; and secondly, it can be applied in a great variety of goods and services, including use and non-use values.

In the present paper the results of a questionnaire survey are presented, in an effort to investigate on people's WTP for better eco-management and protection of the important for Thessaloniki suburban forest of Seich-Sou. The current situation of the forest is characterized by abandonment and low quality of green space and tree flora, as a result of the ten-year on-going Greek economic crisis. However, the forest is regarded as of vital importance, because of its contribution to the quality of urban life: the micro-climate of the Thessaloniki's urban area is strongly and positively affected by the forest; it contributes to flood protection; it offers recreational activities; it offers a pleasant landscape, etc. The paper describes how the questionnaire has been formed in order to seek for reliable answers; how the survey has been organized, designed and implemented; and how the results have been critically assessed, in order to reach to safer conclusions on the WTP answer. General conclusions may be reached on the successfulness of organizing WTP surveys during the Greek economic crisis, by comparing the results of a similar survey conducted some years before this crisis.

Keywords: Contingent valuation method, Seich-Sou suburban forest, Willingness to pay, Questionnaire survey

APPLYING A CONTINGENT VALUATION METHOD (CVM) FOR THE PRESERVATION /RESTORATION OF THREE LAKES IN NORTHERN GREECE

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Abstract
The preservation/restoration of natural environment is usually entailing high cost mostly paid by citizens through taxes. The effect of these taxes is double. The direct effect is the obvious additional income for the State, and the indirect effect is an additional income for the citizen, due to increasing tourism. Since the evaluation of this good cannot be in market terms, we apply a modified Contingent Valuation Method (CVM), which is part of Experimental Economics, in order to find out the order of concern that people have about natural environment. We also, try to investigate their willingness to pay (WTP) for supporting activities for preservation/restoration of three lakes in Northern Greece, in particular, lake of Ioannina, lake of Florina and lake of Kastoria. For the purpose of this research, we use parametric and non-parametric approaches, as well as Linear Regression and Logic Models.

Keywords: Valuation Method (CVM), Natural Environment, Willingness to pay (WTP), Logit Model, Linear Regression, Parametric and Non-Parametric Approaches.

EXAMINATION OF THE PROPOSAL FOR THE CONSTRUCTION OF A PIER AT NEW WATERFRONT OF THESSALONIKI

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Abstract

The waterfront of Thessaloniki in northern Greece is one of the essential features of the city and consists of two parts the old and the new waterfront. It is a reference point for the city and the residents' favorite leisure area, especially during the summer months. In this paper is presented an estimation of the social benefits derived from the potential construction of a pier at the waterfront of Thessaloniki, by the Contingent Valuation Method (CVM). According to the CVM framework, personal interviews were conducted on a representative sample of Thessaloniki residents. The questionnaires included questions about the demographics of the respondents and their opinion about the proposed project, while the citizens' willingness to pay for the maintenance of the project was extracted through a dichotomous choice question. Finally, the statistical analysis of the sample data and the reduction of the results in the overall population lead to an estimate of the total value of the project and its contribution to the welfare of the city residents. Finally, a cost-benefit analysis was carried out to highlight the importance of the project to the welfare of the residents of Thessaloniki.

Keywords: Contingent Valuation method, Cost benefit analysis, Thessaloniki

DRONES AND ENVIRONMENTAL PROTECTION LAW IN GERMANY AND GREECE

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Abstract

Unmanned aircrafts, subsumed under the term "drones", have become in recent years due to their number and wide application a mass phenomenon. Despite the overall contribution of drones to the environmental protection, they may also have negative effects on the environment. There are fears that birds, seals or other animals are disturbed, that the drone controllers enter protected areas or that the landscape is affected. At EU level, the development of special drone rules is at a draft stage. The aviation Regulation (EC) No 216/2008 provides technical safety requirements, the airfields and controllers of unmanned aircrafts, but for a drone weight above 150 kg. Those below that weight are to be regulated by each Member State as they see appropriate. In Germany, the new Drone Regulation entered into force on 7 April 2017. It integrated nature conservation aspects of drone operations into the existing aviation legislation. However, the German nature conservation legislation lacks explicit provisions regulating drone flights as a permissive intervention to protected areas. In Greece, the Regulation of Flights of Unmanned Aircraft Systems (drones) entered into force on 1 January 2017 (Off. Gaz. B 3152/30-9-2016). This Regulation specifies the terms, conditions and the way for obtaining the license of a drone operator, instructor and examiner, but does not contain any specific nature conservation standards regarding the use of drones. The aim of the present paper is to examine: a) the new general legislative framework for drones and b) the legal conflicts arising out of the use of drones in protected areas in Germany and Greece.

Keywords: drones, environmental protection, legal conflicts, protected areas

Protection and Restoration of the Environment XIV

Water and wastewater treatment and management

FROM WASTE TO ENERGY: OPTIMIZING GROWTH OF MICROALGAE *SCENEDESMUS OBLIQUUS* IN UNTREATED ENERGETIC-LADEN WASTEWATER STREAMS FROM AN AMMUNITION FACILITY FOR BIOENERGY PRODUCTION

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Abstract
Wastewaters from industrial ammunition facilities often contain enough nutrients to support microalgae growth. Initial studies showed promising results on sustaining growth of a freshwater microalgae *Scenedesmus obliquus* under a blend of untreated energetic-laden wastewater from an industrial ammunition facility. Initial laboratory studies were scaled up to 100L open raceway reactors for growing *S. obliquus* in the same untreated wastewater mixture. The raceway reactors were set-up up as follows: 50 rpm paddle-mixer speed, 14:10 hours light:dark photoperiod, and 68-95 µmol/m^2/s of light intensity. Continuous monitoring of pH and temperature of the growth medium, periodic analysis of cell density and dry weight of microalgae, and analysis of the media's nutrient contents were performed. Biomass harvesting from the raceway reactors was conducted on a weekly basis and the harvested algal biomass was tested for its oil content. Different conditions such as light penetration, nutrient availability, and retention times were evaluated in order to optimize the biomass growth as well as the oil content of *S. obliquus* in a semi-continuous setting. The results showed that only nitrogen starvation increased the lipid production from 13% to 29% of oil based on the dry weight of biomass, whereas no increment in oil or biomass production was noticed with the increase of light penetration in the two different retention times tested. This study provided significant information towards microalgae growth in energetic-laden wastewater streams. This study also showed that wastewaters from industrial ammunition facilities can be reused for culturing microalgae, which can be utilized for renewable energy production.

Keywords: microalgae, energetic-laden wastewater, renewable energy

ELUTION HISTORY OF BASIC OXYGEN FURNACE SLAG TO PRODUCE AKLALINE WATER FOR REAGENT PURPOSES

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Abstract
This paper summarizes the elution history of packed BOF slag fines (< 10 mm diameter) after a running liquid:solid (L/S) ratio of 1573 L/kg (13111 pore volumes or PV) with an empty bed contact time (EBCT) of 15 min. High alkalinity (>1000 mg $CaCO_3$/L) was obtained up to a L/S 63 L/Kg (526 PV). pH >12 persisted to about L/S <77 L/Kg (580 PV), then monotonically decreased to approximately 11 at 150 L/Kg (1245 PV) when it appears the residual lime/portlandite content was exhausted, which triggered the dissolution of calcium silicates, most prominently, larnite. The pH plateaued thereafter, likely due to buffering effect of silicic acid ($pKa_{1(H4SiO4)} \approx 9.8$) from the larnite. Thereafter, calcium concentration approached background levels of the influent tap water (~12.10 mg/L) whereas the dissolved silicon increased and remained steady between 1 and 10 mg/L. The mass loss of BOF slag fines measured at the end of the experiment was 19.4 wt%. Based on the QXRD data, the sequential dissolution of lime/portlandite and larnite appear to be the dominant processes driving changes in alkalinity, pH, and aqueous elemental composition. Aluminum hydroxide [$Al(OH)_3$] also dissolved, further adding to the amorphous content. The Toxicity Characteristic Leaching Procedure (TCLP) and de-ionized water leaching data suggest that the BOF slag fines are non-hazardous, and exceptionally clean from an environmental perspective and compare very well with the TCLP data of other US BOF slags [Proctor et al 2000], in either the virgin or exhausted form.

Keywords: BOF slag, leaching, XRD, calcium, silicon, pH buffering,

PHOSPHATE REMOVAL USING A REACTIVE GEOCOMPOSITE MAT PROTOTYPE

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Abstract
This paper reports on the development and prototype testing of a *Reactive Geocomposite Mat* or RGM that allows for passive treatment of impacted water is both the cross-plane and in-plane directions. The RGM was fabricated of and Enkadrain™ core and reactive media sandwiched between two non-woven geotextiles. For illustrative purposes, a testing program was carried out to evaluate the potential removal of orthophosphate at typical stormwater concentrations (1 mg/L) using a proprietary phosphorus removal media (PRM-1). As-received PRM-1 was tested in the RGM configuration to assess the response in PO_4 removal, total dissolved solids (TDS) and total suspended solids (TSS) as a function of the hydraulic residence time (HRT). Overall, the PRM-1 was able to achieve greater than 90% removal of dissolved PO_4 concentrations at HRTs greater than 30 seconds. Total PO_4 removal was greatest (near 55%) at an HRT of 60 seconds. It was hypothesized that a majority of the dissolved PO_4 transforms to a colloidal form at HRTs ≥30 seconds, but are kinetically or physically limited from precipitating out of solution. Below a 30-second HRT, the RGM was overwhelmed and PO_4 removal significantly decreased, with an increasing percentage of the total PO_4 found in the dissolved form. TDS concentrations remained under secondary drinking water criteria (500 mg/L) while TSS was below 14 mg/L throughout the test.

Keywords: Passive treatment, geocomposites, mats, water treatment, phosphorus removal

UTILIZATION AND DESIGN OF FIRE SAFETY SYSTEMS WITH THE USE OF TREATED WASTEWATER

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Abstract
Over the past few years, a number of natural phenomena such as earthquakes, greenhouse effect, floods and fires have been taking place, for which reference is made in the present work. Due to the fact that fires can often be catastrophic, various techniques are being applied for their control, which usually are based on the evolution of technology. Thus, the present work examines and designs fire protection plans using treated wastewater originating from the Wastewater Treatment Plant of Patras. By means of this system, the negative effects of the fire are significantly reduced and at the same time the environment is adequately protected and the ecosystem are not subjected to the adverse and harmful effects of the sea and lake, water use, which is used to extinguish the fires. In fact, in the present study, the area that studied was the Industrial Park of Glafkos Patra, where the fire hydrants were fed with the treated water with the assumptions that were made on the basis of the design of the fire safety system. The relevant results and the various computational methods used for the completion of this study were listed accordingly.

Keywords: Fire; fire safety systems; fire detection; Fire brigade; fire hydrants.

CARBON NANOTUBES APPLICATION FOR HEXAVALENT CHROMIUM ADSORPTION FROM CONTAMINATED GROUNDWATER

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Abstract

In recent years, nanomaterials have attracted increasing concern in the sector of water treatment. The present study investigates the removal of hexavalent chromium from groundwater using multi-walled carbon nanotubes as adsorbent. In order to determine the adsorption efficiency of carbon nanotubes batch and column experiments were conducted using groundwater sampled in a heavily polluted area in Asopos river basin, Viotia, Greece. Batch experiments were used for investigating the effect of pH, the concentration of the adsorbent and contact time on the sorption process. Afterwards, by using up-flow column experiments the adsorption capacity of carbon nanotubes for hexavalent chromium was determined. Hexavalent chromium desorption from the nanotubes was also tested in order to check the reversibility of the process and thus to estimate the potential reusability of the nanomaterial. According to the results, the adsorption was found to be a fast process and adsorption capacity was increased with decreasing pH values and increasing the adsorbent's concentration. The desorption efficiency of the nanomaterial indicated that carbon nanotubes have promising potential for environmental remediation as adsorbing materials.

Keywords: Multi wall carbon nanotubes, hexavalent chromium, adsorption, groundwater

TREATMENT OF CHEESE WHEY WASTEWATER BY THE ACTOVE CLAY SEDIMENTS PROCESS

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Abstract

Cheese whey is the liquid waste which is produced following the removal of proteins and fats from fermented milk. The composition of cheese whey is highly variable, and depends on the type of milk, the type of cheese that is produced and the amount of cleaning water that is used. Cheese whey contains high concentrations of lactose, soluble proteins and salt and is characterized by intense odor and by high COD and total nitrogen (TN) concentrations (up to 80g/L and 1g/L, respectively). After cheese whey is mixed with washing waters the concentration of COD and TN often drop by an order of magnitude or even more. Biological treatment of cheese whey wastewater (CWW) is feasible, but, both, aerobic and anaerobic biological treatment processes are problematic and they often fail to produce effluents suitable for discharge into the environment. The present study presents a novel complete process for CWW, based on a series of physicochemical processes: chemical oxidation, coagulation and adsorption on active clay sediments. The study presents findings of the CWW treatment plant of a diary industry, located at the region of Chalkidiki, Greece. The above company produces about 90 ton/d of white (feta) and yellow cheese, and generates about 45 m^3/d of wastewater, with COD, BOD_5, TSS, NT and TP of about 8500, 2800, 600, 140 and 50 mg/L, respectively.

The treatment process is of batch type and consists of equalization, chemical oxidization (pH adjustment, addition of oxidation agent), primary geochemical adsorption on active clay sediments (pH adjustment, addition of active clay sediment powder (geopolymer), addition of nano-coagulant, addition of nano-flocculent), secondary geopolymer adsorption on active clay sediments (addition of active clay sediment powder (geopolymer), addition of nano-coagulant, addition of nano-flocculent) drum filtration, and finally disinfection by addition of sodium hypochlorite solution. The produced sludge is stored in a tank and then it is dewatered through a screw press, while all the concentrate is collected and retuned in the equalization tank. The filtration concentrate is pumped into the sludge storage tank.

Experimental trials indicated that about 40% of both COD and BOD_5 were removed by the chemical oxidation process, while the remaining 80-90% were removed by the primary geochemical process. The secondary geochemical process resulted to COD and BOD_5 concentrations below 90 and 20 mg/L, thus suitable for discharge to the environment. Chemical oxidation did not affect TSS, TN and TP concentrations; which were removed only by the geochemical reactions (outlet concentrations were below 12, 4 and 0.5 mg/L, respectively). The filtration process affected only the TSS concentration, as no reduction was observed to the rest of the monitored parameters. The final effluent qualifies for restricted irrigation. The produced sludge has been stabilized, thus it can be managed as inert material.

The capital cost of the above process (capacity 45 m^3 of wastewater per day) is about 250,000 €, while the operational cost has been measured between 1.70 to 2.50 €/m^3 of inlet wastewater.

Keywords: cheese whey wastewater, active clay sediments, adsorption, oxidation

THE USE OF NANOCRYSTALLINE TITANIUM DIOXIDE IN REMOVING HEAVY METALS FROM WATER: A HISTORICAL PERSPECTIVE OF SCIENTIFIC ADVANCEMENTS

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Abstract

In early 2000, a research group at Stevens Institute of Technology discovered that nanocrystalline TiO_2 (anatase) with a particle size of about 7 nm had very high adsorption capacity for arsenic, lead, and other heavy metals. When the particle size increased from 7 to 30 nm, the adsorption capacity decreased dramatically. A patent application was filed in 2002 and a U.S. patent was granted in 2005 for the invention. This patented nano-crystalline TiO_2 shows high performance for heavy metal removal in water and consists of anatase with crystalline diameter of 7 nm and specific surface area of 330 m^2/g. It exhibited much higher arsenic removal ability than other commercial TiO_2 materials (Degussa P25 and Hombikat UV100, 3.5-22.5 mg/g) (Dutta et al., 2004; Pena et al., 2005a), and was effective in removing other heavy metals such as lead, copper, uranium, mercury, chromium, and cadmium. This invention became the catalyst for systematic studies of the adsorption mechanisms of many heavy metals leading to significant increases in publications on the subject. Before 2003, most of researchers used commercial TiO_2 (Degussa P25) as photocatalyst for oxidation of organic compounds and very few researchers studied its adsorption properties. Degussa P25 is a mixture of anatase and rutile with a particle size of 30 nm and a specific surface area of 55 m^2/g, compared to a specific surface of 330 m^2/g for nanocrystalline TiO_2 (anatase, 7 nm). It has much lower adsorption capacity than nanocrystalline TiO_2. From 2003 to 2017, the annual publication rate on heavy metal removal by TiO_2 has increased from less than 10/yr to more than 90/yr while the annual rate of citations of the related papers have increased from 150/yr to about 1900/yr. A commercial entity was launched in 2005 to market the nanocrystalline TiO_2 product for treatment of arsenic and heavy metals in water. The annual sales of the adsorbent have reached \$7M in 2017. This paper addresses the historical scientific developments of nanocrystalline TiO_2 that have taken place over the past 15 years and the impact these developments have had on water treatment.

Keywords: nanocrystalline TiO_2; heavy metal; arsenic; adsorption; oxidation; water treatment

DEGRADATION OF 2,4-DINITROANISOLE (DNAN) IN AQUEOUS SOLUTIONS BY MG-BASED BIMETALS

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Abstract
The industrial production of munition 2,4-dinitroanisole (DNAN) generates waste streams that require treatment. Treatment of DNAN has been attempted previously using zero-valent iron (ZVI) and Fe-based bimetals. Use of Mg-based bimetals maybe advantageous to Fe in terms of potential higher reactivity and relative insensitivity to pH conditions. This work reports results on the degradation of DNAN by three Mg-based bimetals: Mg/Cu, Mg/Ni, and Mg/Zn. Kinetic data obtained in benchtop-scale batch reactors were modelled according to a pseudo-first-order expression. Parametric studies were conducted to assess the effect of type of bimetal pair and initial pH on DNAN degradation. Pseudo-first order kinetic constants were 0.119, 0.102, 0.018, and 0.009 min^{-1} for Mg/Cu, Mg/Zn, Mg/Ni, and ZVMg, respectively (unadjusted initial pH, 0.5% S/L, 10:1 Mg: catalytic metal). Initial acidification with acetic acid (pH range 3.3-4.0) improved significantly the reaction rate by all of the attempted bimetal formulations and ZVMg producing DNAN degradation half-lives in the range of 0.9-1.4 minutes. Constant temperature experiments at 20, 26, 32, 36 and 45^0C, using the most effective bimetal pair under normal pH conditions (Mg/Cu), were conducted under identical conditions of solids loading (0.5% S/L) and base to secondary metal ratio (10:1). The activation energy for the reductive degradation of DNAN by Mg/Cu bimetal was determined to be 8.18 kJ/mol.

Keywords: 2,4-dinitroanisole, DNAN, insensitive munition, magnesium bimetal, reductive degradation

POTABLE WATER DISINFECTION WITH SILVER IONS DURING SPACE MISSIONS: THE ROLE OF WATER TANK AND WATER SUPPLY MATERIALS

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Abstract
The availability of potable water, both in terms of quality and quantity is essential for the International Space Station (ISS) crew. Potable water is produced on ground and is transported to the ISS. During each launching campaign, water quality complies either to Russian or US standards. The disinfection agent is silver for the Russian type of water and iodine for the US type of water. So far, fluctuations of silver concentration in water have been confirmed and thus, health issues arise concerning the safe storage of potable water supplies in future (long term) missions.

The aim of this study is a) to evaluate the behavior of the disinfectant agent, silver, with various metallic and polymeric wetted materials used throughout the process of water preparation and storage, and b) to examine the phenomena responsible for silver concentration fluctuations in water systems for crew usage. Silver ions were added into Russian type water electrolytically, so as to reach either a silver ions' concentration equal to 10 or 0.5 mg Ag^+/L. Afterwards, water was brought in contact with various surfaces at surface (S) to volume (V) ratio equal to 5.0 cm^{-1} and temperature 30°C, and was stored either for 7d (water with high Ag concentration) or 28 d (water containing low Ag concentration). At the end of the storage period all surfaces were leached, in order to examine the deposition of Ag onto the surfaces. Moreover, solid surfaces were further analyzed (using SEM and/or XPS), in order to elucidate the underlined deposition phenomena.

Silver losses from water containing 10 mg Ag^+/L varied from 7.4% up to 96.8%, while silver losses from water containing 0.5 mg Ag^+/L varied between 62.5% and 100%. Leaching of wetted materials verified the deposition of silver onto their surface. The phenomena that were responsible for silver deposition are discussed thoroughly, with respect to the type of wetted surface material.

Keywords: Silver deposition, Potable water, Disinfection, International Space Station

DETERMINATION OF AMMONIUM IN RECYCLED AND POTABLE WATER SAMPLES FOR SPACE APPLICATIONS

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Abstract

In terms of crew survival, water is the second most consumable needed in manned space missions, after the air, and by far, the most critical with respect to mass. There is a great need for water recycling systems, which are being developed by the European Space Agency (ESA), the Russian Federal Space Agency (ROSCOS-MOS) and the National Aeronautics and Space Administration (NASA), to minimize the water supplied from the ground. So far, water recycling is limited to water recovery from cabin condensate and urine. Ammonium ion is considered as one of the critical chemical components in the waste water stream to recycle as it is the product of urea decomposition. For this reason, there is a need for continuous monitoring of ammonium ion in different stages of recycling process. There are numerous analytical methods, including automated or batch ones, available in the literature for reliable NH_4^+ determination in recycled waters. However, in space, the analytical procedure differs significantly from the one on earth. Sequential injection analysis (SIA) coupled with a fluorimetric detector is a potential candidate for such purpose and has the advantage of not only performing automated analysis, but also improving sensitivity with the possibility of further miniaturization.

Keywords: Trade-off methodology, Sequential injection analysis, Ammonium determination; Fluorimetry, Microgravity, International space station

GIS' CONTRIBUTION IN BIOLOGICAL PROCESSING OF WASTE WATERS IN SMALL SETTLEMENTS. CASE STUDY BY USING AN ARTIFICIAL WETLAND SYSTEM.

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Abstract

The construction of natural waste processing systems should take into account a wide range of territorial and legal factors in order to reduce negative impacts on the environment. This article describes the contribution of Geographical Information Systems (GIS) technology to generate spatial data for site assessment in small settlements, for the construction of natural waste processing systems by using artificial wetlands (AWL's) method. The site suitability is assessed on a scale based on territorial indexes that measure the risk of contamination of the following environmental components: surface water, groundwater, atmosphere, soil and human health. The GIS technology described in this article has been used to evaluate an area for the construction of an AWL in the settlement Orinis of Municipality Serres in Greece, with fewer than 2000 people, where there isn't a waste processing system. The results showed that the use of GIS technology is a base tool to analyse and make decisions for the finding of areas for construction of natural waste processing systems that constitute the optimal solution to protect the environment for small settlements according to the European Union waste management program.

Keywords: artificial wetland system; geographical information systems (GIS); waste waters

PERFORMANCE EVALUATION OF FE-MN BIMETAL MODIFIED KAOLIN CLAY MINERAL IN AS(III) REMOVAL FROM GROUNDWATER

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Abstract
In this study Fe-Mn bimetal modified kaolin clay mineral was synthesized and its performance for As(III) removal from groundwater was evaluated. The adsorbent was characterized using XRF, FTIR and SEM. The adsorbent contains SiO_2 (39.39%), AlO_3 (9.89%), FeO (16.66%) and MnO (4.02%) as main chemical constituents. Its morphology appears more porous and granulated. Effect of contact time, initial pH, initial concentration and co-existing ions on As(III) removal by Fe-Mn bimetal modified kaolin were evaluated using batch experiments. The results showed that the % As(III) removal was above 80% at initial pH range of 2-10 from initial As(III) concentration of 5 mg/L, contact time of 60 min at 250 rpm shaking speed, adsorbent dosage of 0.4 g/100 mL. The adsorbent was successfully regenerated for up to 4 adsorption-desorption cycles. The adsorption of As(III) in presence of co-existing anions can be summarized in a decreasing order of $Cl^- > F^- > NO_3^- > SO_4^{2-} > CO_3^{2-}$. The adsorption data fitted better to pseudo second order reaction kinetic model indicating that adsorption occurred through chemisorption. Furthermore, isotherm data was described by Langmuir adsorption isotherm model. These results proved that Fe-Mn bimetal modified kaolin clay mineral is a promising adsorbent for As(III) remediation from groundwater.

Keywords: Adsorption; Characterization; kaolinite; Pseudo second-order; Langmuir adsorption isotherm.

REUSE POTENTIAL OF CATAPHORESIS WASTEWATERS IN AUTOMOTIVE INDUSTRY

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Abstract

Extensive amount of water input together with various chemicals are required by automotive industry. The cataphoresis process is composed of two main sub-processes: pretreatment and electrodeposion (ED) coating. The retreatment or surface preparation process consists of a series of operations, which includes the hot water rinsing, degreasing, rinsing, surface activation and phosphate coating followed by several rinsing steps. After these operations, electrodeposition coating takes place. As a result, of the cataphoresis process, a metal surface resistant to corrosion and ready to further surface applications is obtained. Recycling and reuse of wastewater in this process is of great importance for sustainability studies as substantial amounts of water is consumed and wastewater is generated out of it. On the other hand, there is limited information in the literature on the reuse of wastewaters produced from cataphoresis rinse pools. The wastewater originating from the cataphoresis process contains heavy metal ions. In order to remove heavy metal ions from these effluents various treatment methods ie. chemical precipitation, adsorption, oxidation-reduction, electrochemical treatment, membrane technologies etc. can be used. The economic and technical limitations resulting from applying the mentioned methods trigger research activities to focus on promising emerging technologies such as removal with nanoparticles. In this context the objective of this study is to evaluate the widely used cataphoresis process of automotive industry in terms of its water consumption and pollution loads, and to investigate the reclamation and reuse potential of segregated effluents arising from this process. The results indicate that 43 % of the continuous effluents arising from cataphoresis process is reusable in nature. The amount of reusable wastewater streams can also be elevated by adding discharges from cooling system and boiler to the mentioned segregated wastewaters. By doing so 20 % of the whole wastewaters can be designated as reusable effluents after being subjected to an appropriate treatment.

Keywords: industrial pollution; wastewater reuse; cataphoresis; automotive manufacturing; segregated effluents.

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